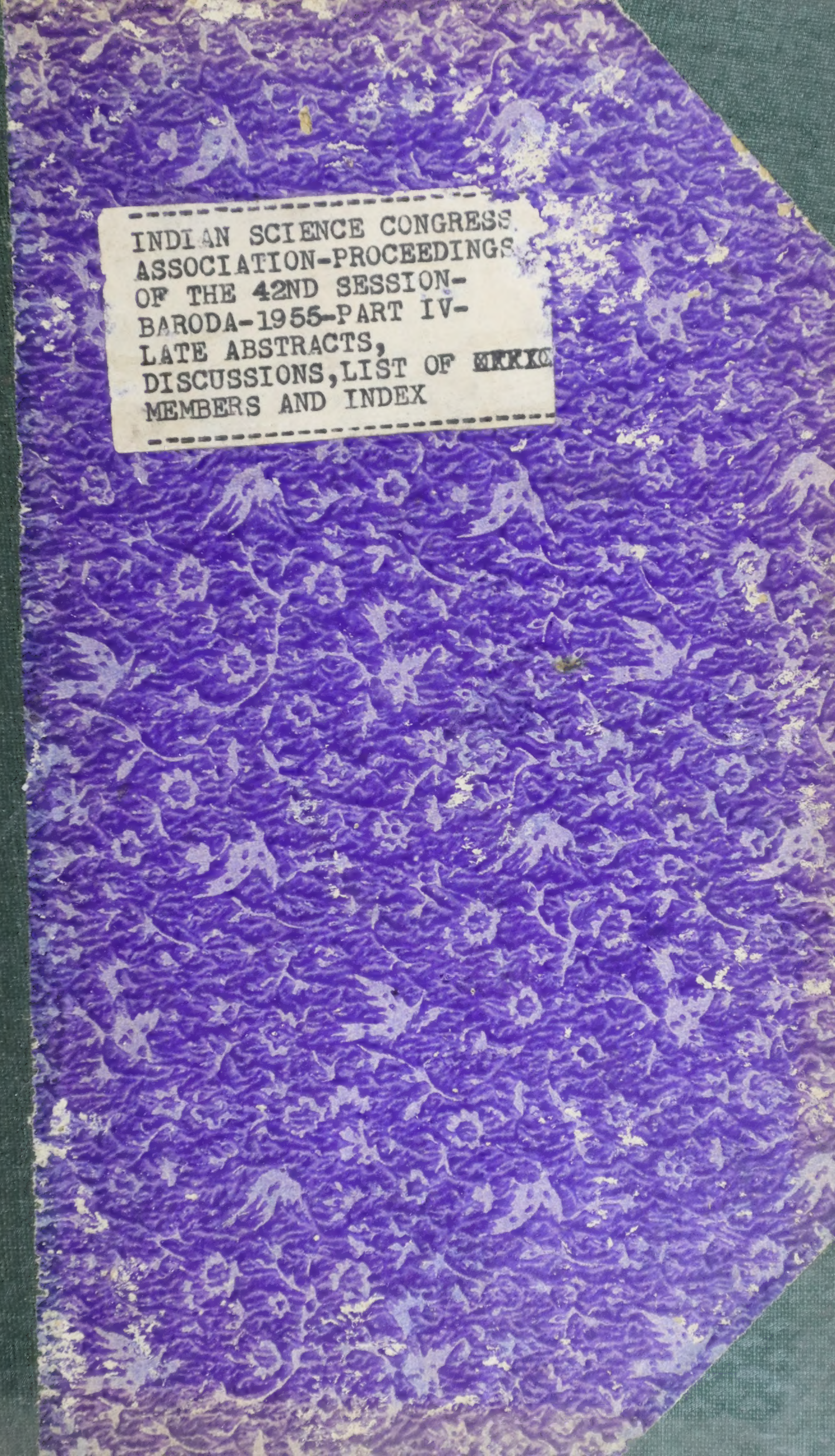

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LATE ABSTRACTS,
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PART IV

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BARODA, 1955

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PROCEEDINGS
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PART IV

LATE ABSTRACTS

Section I, Mathematics.

31. On p-variations of Functions.

T. P. SRINIVASAN

Let f be a real valued function on the real line R^1 and let $\{a, b\}$ be any interval. Let $a=x_0<x_1<x_2\ldots<x_n=b$ be any partition of $\{a, b\}$ and let $V\{a, b\}$ denote the supremum of the sums $\sum_{i=1}^{n} | f(x_i)-f(x_{i-1}) |$ taken over all partitions of $\{a, b\}$, Then $V\{a, b\}$ is called the *variation* of f on $\{a, b\}$, and f is said to be of *bounded variation* on $\{a, b\}$ if $V\{a, b\}<\infty$. It is known that

(1) f is of bounded variation on $\{a, b\}$ if and only if it is the difference of two monotone functions;

(2) interpreting $V\{a, b\}$ as a set function on the class of all left-open, right-closed intervals $(a, b]$, it can be extended to a finitely additive measure μ on the ring of all finite disjoint unions of half-open intervals $(a, b]$, and

(3) μ is actually countably additive in the case of a "normalised" function f.

By slightly modifying the definition of $V\{a, b\}$ and replacing the absolute value of the difference $(f(x_i)-f(x_{i-1}))$ by its pth power $(p\geqslant 1)$, Wiener has defined the pth variation of f for $p\geqslant 1$, denoted by $V^p\{a, b\}$ such that $V^1\{a, b\}=V\{a, b\}$. He has further shown that if $V^p\{a, b\}<\infty$, then f is continuous on $\{a, b\}$ if and only if $V^{p+1}\{a, b\}=0$. In this paper these results are generalized for functions in R^n, the Euclidean space of dimension n.

32. On the equations of the structure for the projective and conformal geometry.

B. V. SINGBAL.

Let μ be an n-dimensional ε^3 manifold. Let $P_n=SL_{n+1}$ be the projective group of n variables=special linear groups of n+1 variables, S_n be linear group in n variables which takes the n dimensional sphere S^n onto itself taking great circles

S^{n-1} into themselves. Let E (μ, P_n, P_n) resp. E(μ, S_n, S_n) be principal fibre bundles with μ as base space and P_n resp. S_n as fibre acting on itself by left translations.

Theorem 1. If a projective connexion is defined on μ then there exist $(n+1)^2$ linear differential forms w_{ij} defined on E$(\mu, P_n\ P_n)$ satisfying

$$dw_{ij} = -\Sigma w_{i\alpha} \wedge w_{\alpha j} + \Omega_{ij}. \quad \begin{matrix} i=1, \ldots n+1 \\ j=1, \ldots n+1 \end{matrix}$$

$$\Sigma w_{ii} = o.$$

where Ω_{ij} is the curvature matrix.

Theorem 2. If a conformal connexion is defined on μ then there exist n^2+1 linear differential forms w_{ij} ; $i=1, \ldots n$; $j=1, \ldots n$ and satisfying

$$dw_{ij} = -\Sigma w_{i\alpha} \wedge w_{\alpha j} + \Omega_{ij} \quad \begin{matrix} i=1, \ldots n \\ i=1, \ldots n \end{matrix}$$

$$w_{ij} = -w_{ji}$$

and $dw=0$.

It is believed that the equations in Theorem 2 are new.

Section II, Statistics.

30. The Physical Significance of the Growth constants of the Skew Logistic Elongation Curve of Sugarcane Crop.

P. S. SREENIVASAN *and* P. S. NAYER.

The elongation curve of a field crop is signoid in shape and skew logistic or the 'growth curve' of the form

$$y=d+k/1+e^{a_0+a_1x+a_2x^2+a_3x^3}$$

was found to be most appropriate. A series of such curves have been fitted in the past to the elongation data of sugarcane crop grown at Poona. In the present paper, a normal elongation curve for the P.O.J. 2878 variety of sugarcane has been generated and the main characteristic of such a curve is briefly indicated. Also the range of variation of the various constants of the skew logistic curve along with the physical significance of any change in these constants has been brought out by graphical methods.

31. The Spurt in the Expectation of Life in Mysore State.

T. CHANDRASEKHARAIYA, Mysore and
E. R. SUNDARARAJAN, Bangalore.

This paper discusses the various problems relating to the birth and death statistics of the Mysore State. Adjustment for the incompleteness of the data has been suggested and Life Table for the State for 1953 has been constructed.

32. On the Testing of outlying Observation.

A. KUDO, Calcutta.

Let $X_i^{(1)}$ $(i=1, 2, \ldots N_1)$ be distributed in $N(m_i, \sigma^2)$ respectively, $X_i^{(2)}$ $(i=1, 2, \ldots, N_2, N_2 \geqslant 0)$ in $N(m, \sigma^2)$ and $X_i^{(3)}$ $(i=1, 2, \ldots, N_3, N_3 \geqslant 0)$. Our null hypothesis is $H_0\,(m_1=m_2= \ldots =m_{N_1}=m)$ where m is free. We have N_1+1 alternative hypothesis $H_i\,(m_1=m_2= \ldots =m_{i-1}=m_i-\Delta=m_{i+1}= \ldots =m_{N_1},$

$\triangle > 0$). Our problem is to find out a suitable decision procedure as to these N_1+1 decisions.

Let
$$x_M = \mathrm{Max}\, X_i^{(1)},$$
$$i = 1, 2, \ldots, N_1$$
$$\bar{x} = (\Sigma X_i^{(1)} + \Sigma X_i^{(2)})/N_1 + N_2$$
$$s^2 = \Sigma(X_i^{(1)} - \bar{x})^2 + \Sigma(X_i^{(2)} - \bar{x})^2 + \Sigma\left(X_i^{(3)} - \frac{\Sigma X_i^{(3)}}{N_3}\right)^3$$

The decision procedure: if $(x_M - \bar{x})/s \geqslant \lambda$, select H_M otherwise select H_0, is found to be optimum in the following sense. This maximizes the probability of making correct decision when H_i is true among the decision procedures which are invariant under the change of scale and location parameters and whose probability of making correct decision when H_i is correct does not depend on i but only on $\triangle/\sigma$ and the same when H_0 is correct is fixed for any σ.

It should be noticed that if $N_2 = N_3 = 0$, this is the Pearson-Chandrasekhar's statistic for the testing of outlying observation.

33. Simultaneous Estimation of Parameters in Multiple Regression Analysis with Correlated Residuals.

K. S. Rao, Bombay.

D. G. Champernowne (1948) considered the problem of serial correlation among the residuals in multiple regression analysis and estimated the autoregressive coefficients along with the regression coefficients. He considers a relation of the form

$$Z = \sum_{r=1}^{k} \lambda_r f_r + \lambda_0 + X \tag{3.5 :89}$$

where $f_1, \ldots f_k$ are independent of X and X is an unpredictable disturbance. He postulates a relation of the form

$$(X_t - c) - b_1(X_{t-1} - c) - \ldots - b_s(X_{t-s} - c) = \varepsilon_t \tag{3.5 :90}$$

Under various assumptions that some of the parameters are known he proceeds to obtain the best estimates for the remaining. In this paper has been developed, for the case when n is large, a technique of simultaneous estimation of parameters at the same time as the regression coefficients strictly under conditions when the least squares method of estimation is valid.

Section III, Physics.

49. Entropy and Specific Heat of Liquid He^3.

E. C. George, Bombay.

The entropy and specific heat of liquid He^3 in the region of very low temperatures have been studied experimentally by several investigators.[1] Based on the model of an ideal Fermi-Dirac gas, Singwi[2] has calculated these thermodynamic functions. It has been pointed out[2] that because of the extremely large zero-point energy, the gas model is applicable. The calculated and experimental values show good agreement in the region $\backsim$ 1°K to 2·5°K. Below 1°K, the experimental values do not agree with the theoretical ideal gas values. This is perhaps due to the fact in the above calculation,[2] the interaction between helium atoms was neglected. Using a perturbation method, we have recalculated the entropy and the specific heat with a Lennard-Jones potential between the He atoms. The expressions are given below:

$$S=S_{\text{Ideal}}=\frac{2\pi N^2}{V}\ \frac{3\pi^2}{T}\left(\frac{kT}{\eta_o}\right)^2\left[1-\frac{\pi^2}{24}\left(\frac{kT}{\eta_o}\right)^2(2\pi rko)^2\right]$$

$$\times\int\left[\frac{\text{Sin } 2\pi rKo-2\pi r\,Ko\text{ Cos }2\pi rKo}{(2\pi rKo)^3}\right]^2 U(r)\,r^2\,dr$$

$$Cv=Cv_{\text{Ideal}}-\frac{2\pi N^3}{V}\cdot\frac{1}{T}\cdot\left(\frac{kT}{\eta_o}\right)^2\left[1-\frac{\pi^2}{8}\left(\frac{kT}{\eta_o}\right)^2(2\pi rko)^2\right]$$

$$\times\int\left[\frac{\text{Sin } 2\pi rKo-2\pi rKo\text{ Cos }2\pi rKo}{(2\pi rKo)^3}\right]^2 U(r)r^2dr$$

where η_0 is the Gibbs free energy per particle at $T=O$ and K_0 corresponds to the top of the Fermi distribution at $T=O$.

$U_{(r)}$ is the intermolecular potential field. It is seen that the change in the values of S and C_V is in the right direction and quantitative agreement obtained in the low temperature values.

Numerical calculations have been made with a Lennard-Jones intermolecular field of the form

$$U_{(r)}=4\varepsilon\left[\left(\frac{r}{\sigma}\right)^{12}-\left(\frac{r}{\sigma}\right)^{6}\right]$$

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   Osborne, Abraham and Weinstock—Phys. Rev., *94*, 202 (1954).
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50. Ultrasonic Velocity and molecular Volume.

M. RAMA RAO, New Delhi.

A plot of Rao's constant $R=v^{1/3}V$ against M, the molecular weight of successive numbers of homologons stries reveals that for any one series the points lie on straight lines having the same slope viz. $R=\alpha M+\beta$ where α is independent of the series having a value of 14 according to Rao and 13·535 according to Lageman Wolsey etc. and 13·56 according to Parthasarathy. Parthasarathy however used a modified form of Rao's equation namely

$$\frac{v^{1/3}}{\rho}=\alpha+\frac{\beta}{M}.$$

The explanation of the constancy of α for all series is to be traced to the fact that the difference in R value for two successive numbers of homologous series differing in molecular weight by 14 is a constant having an average value of 195 according to Rao and 189 according to others. The result is extended to the case of the Parachor.

51. Comparative study of the roles of Argon and Oxygen in the suppression of I(P) with respect to II(P) system of N_2 as observed in air.

D. D. DESAI, Bombay and N. R. TAWDE, Dharwar.

Influence of argon on the intensity distribution in I (P) and II (P) systems of N_2 has been studied in the three mixtures, viz. (i) a trace of argon in N, (ii) 50 : 50

mixture of A and N_2 and (iii) a trace of N_2 in Argon, by one of the authors (D.D.D.). Similar study corresponding to 5%, 20%, 50% and 95% mixtures of O_2 in N_2 has also been done by Koregaonkar for the role of oxygen.

From the results of these two studies, an attempt has been made, in this paper, to analyse the comparative rôle played by a trace of argon and 20% oxygen, in bringing about the relative suppression of I (P) system with respect to II (P) system in air.

52. Transition Probabilities in bands of Blue-green system of TiO by numerical integration methods of Bates and of Pillows.

M. V. Shingre, D. D. Desai, Bombay and N. R. Tawde, Dharwar.

Of the various methods available for the evaluation of transition probabilities of bands of diatomic molecules, Hutchisson's earlier method has been applied, to the bands of blue-green system of TiO molecule in this laboratory. Since this method does not take into account the asymmetric nature of the molecule so closely, it was thought desirable to calculate the values of transition probabilities of this band system by the method of numerical integration as given by (1) Bates and (2) Pillows' improved method. These methods have shown better agreement with experimental values in some band system of N_2.

For this purpose, several integrals are evaluated with the knowledge of appropriate constants from Hertzberg's and Phillip's data respectively and final values obtained from the squares of the overlap integrals. Theoretically calculated values are compared with experimental ones. A better agreement appears to exist for lower quantum numbers.

53. Influence of Solar Activity on Weather.

S. Rangarajan, Kodaikanal.

Some evidence is now available to indicate that the general circulation of the atmosphere is influenced in a rather complex way by variations in solar activity, but at present very little is known about the underlying mechanism. There is, however, sufficient justification to assume that variations in the solar ultraviolet radiation and corpuscular radiation are mainly responsible for the observed solar-weather relationships. A logical step towards a better understanding of the underlying phenomena seems to be a study of short period changes in solar activity and the associated changes in tropospheric weather.

Recently the author reported a tendency for surface barometric pressures at some stations to undergo a 27-day recurrence tendency during periods of low sunspot activity. Further examination of pressure data has generally confirmed that the 27-day recurrency tendency does occur at many stations under favourable conditions. This phenomenon, associated with solar rotation, seems to indicate a direct influence of solar corpuscular radiation on day to day changes in barometric pressure. To study the exact nature of this influence, 37 occasions were chosen during the period 1952-1954 when there was a sudden increase in geomagnetic activity from relatively quiet conditions. These occasions were taken as coincident with a sudden impact of solar corpuscular radiation on the upper atmosphere. In 25 out of the 37 cases, a widespread fall of barometeric pressure was found to occur over the Indian region about three days after the impact of corpuscular radiation. It is proposed to extend this investigation to cover past epochs also of low sunspot activity.

293. Salinity in Rain water.

A. K. MUKHERJEE, Jodhpur.

An equation connecting the salinity of rain water with actual precipitation has been derived. This has been verified by previous workers' data on the subject. The important conclusion arrived at in the light of this new equation is that NaCl probably remains as bigger particles suspended in the air.

294. A New Technique in Electrolytic Practice.

H. V. K. UDUPA *and* B. B. DEY, Karaikudi.

The principles underlying the use of rotating electrodes in electrolytic practice have been discussed by the authors in earlier publications. The application of this technique for electrolytic preparation of a few chemicals are discussed in this paper.

The preparation of p-aminophenol, salicylaldehyde and calcium gluconate using this new technique have been discussed. The apparatus used is also described.

The suitability of the technique for commercial production of these chemicals is briefly discussed also.

295. Utilisation of South Arcot Lignite for the Production of Calcium Carbide.

A. JOGARAO *and* A. SREENIVAS, Karaikudi.

This paper indicates the possibilities of using the extensive deposits of lignite recently found at Neiveli in South Arcot District, Madras State, for the production of calcium carbide in South India, which at present, suffers from particular handicap of having to depend upon the supplies of coal from the distant coalfields of Bengal and Bihar. Typical results of a series of experiments using a submerged arc for the laboratory scale preparation of calcium carbide, to begin with, are presented in which air-dry lignite and lignite-char are substituted for coke. A small percentage of petroleum coke was also added to the limestone lignite-char combinations in the course of certain experiments. The calcium carbide produced in the various experiments was tested for the gas yields in accordonce with the procedure laid down in the British Standard Specifications. From the values of the gas yields obtained, it is pointed out in this paper that while lignite-char as well as green lignite (air-dry) have shown definite promise as good substitutes for the usual grades of coke ordinarily used in commercial practice in this country a small addition of about 10 to 15 parts of petroleum coke to 50 parts of lignite-char has given a product which not only passes the B.S.S. tests but which has given more than the maximum yield of gas as stipulated in the B.S.S.

296. Influence of Inorganic Salts on the R_F Values of Amino Acids.

G. C. GOSWAMI, A. SAIKIA *and* P. C. GOSWAMI, Gauhati.

The R_F values of amino acids have been found to be affected profoundly by the inorganic salts. The higher the concentration of the salts, the greater is the effect. The effect decreases as the salt concentration diminishes and ultimately tends to disappear altogether. Where concentration of inorganic salts is of the order of M/100, or higher, it is necessary to separate them first in order that the amino acids can be identified by their R_F values.

Section V, Geology & Geography.

102. The Geographical Background of the Location of Cottage Industries in Uttar Pradesh.

S. M. TAHIR RIZVI *and* MASUDUL HASAN, Aligarh.

The paper attempts to evaluate the location of various cottage industries in the state of Uttar Pradesh as determined by the geographic factors. A rapid survey of important cottage industries has been made with a view to prove that their existence, growth and development are, more or less, due to geographic factors and their interaction.

Having a large size, an advantageous location, an agriculturally productive climate, a varied combination of natural resources, and a fair industrial capacity, it is in the fitness of things that the state is well endowed with cottage industries which have much scope of further expansion in the industrial planning of the state. Geographically well situated; agriculturally more productive in respective of raw materials for industries; economically more advanced; and sociologically more populous in India; the state is undoubtedly destined to hold a dominant position in respect of development and expansion of cottage industries planned and organized under geographical conditions.

The present demographic position of the state, the disequilibrium which exists between agriculture and industry, make it imperative that industries, particularly the cottage industries should receive careful consideration by the Government as well as the public.

103. The Tasar Silk Industry of Bihar.

S. A. MAJID, Patna.

The paper is a brief study of the Tasar silk industry of Bihar. It deals with the geographical home of the Tasar Silkworm (Antheraca Paphia), the tasar hosts, the rearing and collection of cocoons, the extent and value of cocoons produced, the reeling and weaving industry, the nature, value and market of the manufactured goods, the important manufacturing centres and the prospects of the industry.

104. Argentite from the Zawar Mines, Rajasthan.

S. RAYCHAUDHURI, Calcutta.

Besides occurrence in the native state, silver is found to be present as the mineral Argentite (Ag_2S) in the lead-zinc-silver ores of the Zawar Mines. This is revealed from an examination of some polished sections of the ores under the ore-microscope aided by tests employing other techniques including chromographic contact print method. The mineral occurs in minute specks and patches, infilling space between galena or sphalerite grains, or sometimes as minute blebs along cleavage in galena. The mineral is greyish-white with a distinct green distinguishing it easily from native silver, possesses a weak reflection pleochroism and a very low hardness and is isotropic. Etch tests show HNO_3, HCl, KOH negative while

KCN, $FeCl_3$, $HgCl_2$ positive reactions. Light appears to etch the mineral grey hiding sometimes its apparent identity. The silver radical is confirmed by the microchemical bichromate test and the electrographic contact prints using *p*-dimethyl-aminobenzylidene-rhodanine which gives a characteristic red-violet colour. Arsenic, antimony etc. are found to be absent in the constitution of the mineral. It also appears probable from contact print tests so far made, that the silver may not occur in the solid solution in galena or sphalerite but exists as argentite or in the native state. The paragenesis of ore minerals found associated with argentite has been in the order—pyrite, sphalerite, galena and argentite.

105. Syllabus of Local Geography in Secondary Schools.

L. Y. KULKARNI, Dharwar.

In order to test the knowledge of Local Geography, 203 students from the First Year Arts and First Year Science were tested. The questionnaire including 14 questions of elementary nature was given and they were asked to answer them within half an hour. Out of 203 candidates examined, only 20% have passed; 14 of them obtained less than 10 marks and 4 students got zero! This test has revealed that Local Geography is neglected in Secondary Schools. Secondly, the causes for this state of affairs are discussed : (1) Geography is not considered as a major subject. (2) No provision of Local Geography in the syllabus. (3) Teachers are not trained. (4) Lack of Funds. (5) Rigid curriculum. Remedies have been suggested to improve the status of geographq. Finally a syllabus of Local Geography is proposed for the VIII, IX and X standards which includes the observation and records of temperature etc., Surveying and Field-work, and Interpretation and the making of maps. Surveying of the village is proposed for the VIII standard, surveying the school area is suggested for the IX, and survey of the School District is proposed for the Standard X.

106. Natural Regions of India—a Problem for the Indian Geographers.

PRAMATHANATH HORE, Calcutta.

This paper deals with how the concept of "Natural Region" changed from the first decade of the tweneieth century to the present day. But even to-day the geographers differ in their definitions of "Natural Region". Even in countries where much geographical works have been done the natural regions delimited by one rarely coincide with those made by others. The paper also points out how different authors have divided India into natural regions according to their own concepts of Natural Regions. This is why in India the natural regions done by one author differ much from those worked out by others. Inadequate data and lack of geographical research are responsible for divergence.

Finally the paper puts forward some questions before the Indian geographers :

1. What should be the correct definition of a Natural Region and a Geographical Region? What are the distinctions between them?

2. What should be the basis or what indices should be used to delimit a natural region and how this should be worked out?

3. What should be the basis of dividing the natural regions into sub-regions?

In conclusion the paper suggests that the discussions of the symposium should be published and made available to the Indian as well as to the foreign geographers.

107. A study in Coastal Settlements, North Kanara District, Bombay State.

M. S. HONRAO *and* V. R. PRABHU, Dharwar.

This paper aims to examine the urban landscape of North Kanara Coastlands, with a case study of its leading town, Karwar (14°48′ : 74°8′). The present urban structure of the town shows clearly how the natural and human factors have played their role in turning the fishing village into a modern town. Due to its spacious natural harbour and its orientation English enterprise was attracted. Noticeably this has been the main spring of urbanisation of the original fishing village.

Unlike all other towns Karwar has more than one nucleus. Kone which is the main nucleus shows oldest structures reflecting the flourishing conditions of commerce which the port enjoyed. As is common of old parts, this area is closely built and populated. The Administrative Area with the Coastal situation exhibits a landscape pattern with English influence. These have contributed to the development of the present Central Zone. It is the commercial, educational and social centre of the town.

The Port area still reflects the prosperous past. Kodibag—the river port, has added to its activities.

The modernized fishing industry has imparted to the port landscape a characteristic aspect.

Population distribution exhibits a pattern fitting to the general build of the town revealing segregation.

Almost the whole town is unplanned, showing a need for conscious planning.

108. New "frontier" in the Micropalaeontology of the Trichinopoly marine beds.

S. S. GOWDA, Bangalore.

Micropalaeontological studies have shown in recent times that there are some fossils which are not given the attention they deserve and which have been 'orphaned'. Among such orphaned microfossils which constitute new frontiers in the field of micropalaeonthology in general, one (holothurians) has been dealt with by the author (*Curr. Sci.*, 23, pp. 152-53).

The present paper deals with the detailed description with measurements of the various genera found in these beds. While some forms resemble those of the modern times, there are a few which resemble those of Eocene and, in some cases, those from the Liassic also. The following genera are described: *Zygothuria*, *Mesothuria*, *Myriotrochus*, *Laetmophasma* (2 species), *Astichopus*? and *Ancistrum*. It is very interesting to find the last mentioned genus in the Cretaceous bed, for it was considered as purely Palaeozoic in age till Issler found it in the Liassic of Schwaben.

Since they are restricted in vertical range in the Trichinopoly marine beds they are considered as of correlative value "regardless of whether they are made in the same factory and of the same metal." The author would be grateful to those who would, by their criticisms and comments, help him in establishing their biological relationship and also their distribution in time and space.

109. Mathura—a Socio-Geographic Study.

S. D. MISHRA, Nagpur.

This monograph is an objective and factual socio-geographical study of the town of Mathura with due emphasis on its historical back-ground. The settlement pattern is the outcome of the riverine and the city morphology. The narrowness of lanes and the lattice styled old houses of red sandstone reflect a deep seated geographical basis incorporating the space relationships and the durability of the building material. The paper deals with the following points in detail :—

Ancient History and Archaeology—History of excavation—History of Museum—The Mathura Art—River side and important features—Topographical-profile of the Settlement—House types—Chief industries—Choubas of Mathura—Conclusion.

Section VII, Zoology and Entomology.

124. Respiratory Mechanism in the Chelonia.

J. C. GEORGE *and* R. V. SHAH, Baroda.

In the three pond turtles *Lissemys punctata granosa, Lissemys punctata typica,* and *Lissemys punctata serrata* and the tortoise *Geomyda trijuga* it is found that the lung wall possesses an outer striated muscle layer. It is suggested that it helps in the contraction and relaxation of the lungs which cause expiration and inspiration respectively and that it may be universally present in all chelonians.

125. Fauna of the Kashmir Valley: Leeches.

T. D. SOOTA, Calcutta.

The author gives an account of the leeches from Kashmir Valley present in the collections of the Zoological Survey of India, including three species, viz., *Glossiphonia complanata* Linnaeus, *Erpobdella octoculata* Linnaeus and *Haemopis indicus* Bhatia, collected recently by a party from the Zoological Survey of India that visited the valley during May-June, 1954. Twelve species, belonging to eight genera, known so far from Kashmir, have been listed. The preponderance of palaerctic species among leeches of Kashmir suggests that this group entered Kashmir Valley from Europe and Northern Asia. Presence of polytypic species indicates their great antiquity.

126. On a new species of trematode belonging to the genus *Philophthalmus* Looss, 1899, from the eyes of Bird in Hyderabad-Deccan.

GANESHPERSHAD JAISWAL, Hyderabad (Dn.).

In this paper a new species of *Philophthalmus aquillai* is described from the orbital cavity of a Tawny Eagle, *Aquilla rapax.* The species under study differs from all the known forms in the advanced position of its genital pore, which is much above the intestinal fork and also in the disposition of the gonads which are located in the hindermost part of the body.

127. On the correlation between fish-food and fish-gut in food fishes of U.P.

S. M. DAS *and* S. K. MOITRA, Lucknow.

Although it is common knowledge that the length of the alimentary canal in fishes varies according to their food habits (herbivorous, omnivorous or carnivorous), yet few quantitative data are available of the ratio that exists between the gut-length and the body length in Indian fishes. A quantitative ratio has been established for each species of fish studied, and we find this ratio to be fairly constant. It is the highest in herbivores, falls in omnivores and is the lowest in carnivores.

The limits of the three categories may be seen in a curve constructed from the species-constants. 515 fishes of different sizes belonging to the following species viz., *Cirrhina mrigala* (Ham.), *Cirrhina reba* (Ham.), *Amblypharyngodon mola* (Ham.), *Gadusia chapra* (Ham.), *Barbus stigma* (C. & V.), *Rohtee cotio* (Ham.), *Mystus vittatus* (Bloch), *Mystus cavasius* (Ham.), *Callichrous pabda* Ham., *Chela bacaila* Ham., *Wallagonia attu* (Bloch), *Ophicephalus striatus* Bloch, *Glossogobius giuris* (Ham.). *Ambassis ranga* (Ham.), *Ambassis nama* (Ham.), were obtained locally for routine examination of their gut contents. On the basis of the dominant food the fishes were broadly divided into three groups viz., herbivores, omnivores and carnivores. On plotting the total gut-lengths against the total body-lengths of the fishes on a graph a definite ratio was found to exist for each species and was expressed as a straight line. Of the fifteen species studied only two have intestinal caeca while the length of the different regions of the gut varies radically in the different species, and is correlated with the food-habits of the species.

128. On fish mortality in tanks and ponds of U.P.

S. M. DAS *and* S. K. MOITRA, Lucknow.

An unusual phenomenon of mortality of fresh-water fishes occurred in two tanks in the vicinity of Lucknow on the 3rd of June, 1954, just after the onset of the first rains. A list of the species, age-groups, and quantity of the fishes destroyed is given below :—

Species.	*Age-groups.*	*Quantity.*
Catla catla (Ham.)	2 to 3 years.	2½ maunds.
Gadusia chapra (Ham.)	2 to 3 years.	3 maunds.
Mystus seenghala (Sykes)	2 years.	5 seers.
Labeo calbasu (Ham.)	2 to 3 years.	2 maunds.
Labeo rohita (Ham.)	2 to 3 years.	2 maunds.
Cirrhina mrigala (Ham.)	2 to 3 years.	2 maunds.
Wallagonia attu (Bloch) ...	2 to 3 years.	1 maund.

The causes of the mortality as ascertained by preliminary observations are as follows :—

(*a*) Death due to clogging of gills by means of algae flowering in June; the gills are choked and no respiration is possible.

(*b*) Death due to liberation of H_2S in the surrounding water, just after the first rains, and the washing into the tank of putrified material from the surroundings.

(*c*) Death due to increased amount of CO_2 in the environment and depletion of O_2 content on account of increase in zooplankton.

129. On intermediate stages in the evolution of afferent arches from fishes to amphibia.

S. M. DAS *and* D. B. SAXENA, Lucknow.

There is a common origin of the third and fourth afferent branchial arteries in *Clarias* as also in *Ophicephalus* (Das & Saxena, 1954). We have found that in *Heteropneustes* the second, the third and the fourth afferent arteries all originate from the same aperture. This is clearly an advance over all the fresh-water fishes worked out so far. It would not be an exaggeration to state that a further advance in this line (of origin of the afferent arteries by a common aperture) would lead us to the Amphibian condition, where all four afferent branchials have a common root (as in a 12 mm. tadpole of frog). This series may be shown as starting from the *Labeo* condition, where all four afferents open separately, passing through *Clarias* and *Ophicephalus* condition and finally through *Heteroneustes* condition to the amphibian stage.

130. The myology of *Funambulus palmarum* Waterhouse (the Indian palm squirrel).

S. M. DAS, Lucknow.

The present paper is the first contribution on the functional anatomy of the squirrel.

Over one hundred and forty muscles have been identified in the squirrel. The chief distinguishing myological characters of *Funambulus palmarum tristriatus*, the Indian palm squirrel, may be summarised as follows:—The masseter is very large and does not pass through the infra-orbital foramen; the transverse mandibularis is well marked and the large digastric is divided completely into two bellies; the omohyoid is well marked and the geniohyoids of the two sides coalesce posteriorly; the levator claviculae arises from the atlas, and the subclavius is large, there being no scapulo-clavicularis. The scalenus anticus is absent; of the three heads of M. coracobrachialis only the first is present and well-developed; the flexor hallucis longus is well developed and does not join the flexor digitorum longus; the tendons of the manus are somewhat modified due to only four digits being present.

131. Main trends of fauna investigation in Uzbekistan.

T. Z. ZAKHIDOV, Uzbek SSR.

A general review of the zoological investigations in Uzbekistan and the complex character of an elaborate ecological approach in the determination of the natural resources of a definite territory has been discussed in this paper. The well co-ordinated research work of zoologists, botanists, soil scientists and hydrobiologists made it possible to arrive at practical conclusions to step up production The complex study also produced a thorough zoogeographical and geobotanical maps of Uzbekistan. All the flora and fauna of the republic and their distribution are now known. The main connections and links of interdependence have been determined between vegetation and definite groups of animals, and this makes it possible to speak of bioscenoses. Ways and means of changing natural aggregates for the purpose of enriching their fauna have ushered. The data obtained have served as a basis for implementing plans for refashioning nature and for reclaiming new lands for further development of the agricultural economy of the country.

Section VIII, Anthropology and Archaeology.

23. Bio-geological Evidence bearing on the Destruction of the Indus Valley Civilisation.

M. R. SAHNI, Calcutta.

Recent disasters as a result of floods in Assam and other parts of the Indian continent and of the world have focussed attention on the widespread destruction following in their wake, leading to submergence of vast tracts of land and obliteration of entire townships. Some rivers are more prone to floods than others and also possess more unstable courses. There is clear evidence that the Indus belongs to this vagrant category. While engaged in field work connected with water supply problems in Sind during 1940-1941, the author elicited evidence that a flood of unprecedented magnitude must have occurred in the Indus valley in earlier times of which there is now no record, legendary or historical. Attention was first drawn to this in the author's book *"Man in Evolution"* (Orient Longmans 1952).

The author is of the view that this flood was responsible for the destruction of the Indus valley civilisation. The evidence consists of the presence of a considerable thickness of alluvium containing freshwater shells, on the hillocks situated near the Indus banks, of which Budh Takhar in Southern Sind is one. The alluvium here occurs about 130 ft. above present sea-level, that is, 70 feet or so above the present river-bed. As there is no evidence to show that the level of this area and, therefore, of the Indus river-bed was higher than the present, within the last three to four thousand years, the position of this alluvium can only be accounted for by a flood of unprecedented magnitude. Such a flood would submerge everything around the Indus for miles, destroying all trace of civilisation (the Indus Valley Civilisation in the present case). The most significant fact about the alluvium is that it entombs the remains of freshwater and lacustrine shells which suggests prolonged submergence.

The above evidence was confirmed by Mr. Y. Nagappa of the Burma Oil Company, who found about 4 feet of alluvium on a hill-top opposite Jhirak, resting at an altitude of about 75 feet above the present Indus bed.

The paper discusses the changes in the course of the Indus and their possible causes. There is little doubt that apart from normal floods which bring about temporary rise in water-level and alteration in the direction of flow of rivers, earthquakes have played an important role in these phenomena.

24. Rehabilitation of Ex-criminal Groups.

B. H. MEHTA, Bombay.

The problem of the ex-criminal tribes is one of the most difficult problems confronting India after Independence.

Need of a scientific approach to guide the proper understanding and treatment of the problem, especially at the community level. Present day tendency of a universal approach to entirely different kinds of social problems is undesirable. The true implication and content of a rehabilitation programme must be understood before objectives and methods of treatment of ex-criminal tribes are determined.

Lack of data and information about historical background to reveal who were the ex-criminal tribes. Several possible theories to explain who they are, and how they came to be considered criminals. They are not tribes ; but only gangs, groups, small communities, or maladjusted sections of major and large tribes, and village communities.

Causes of maladjustment : Individual factors, especially psychological ; lack of adjustment to habitat ; difficulties of economic life ; inability or unwillingness to adjust to law and order concept of modern State, feudal concepts of property, land and forest policies of British Government ; conflict with caste system, etc.

Historical evaluation of British approach to the problem, and consequent protective and preventive measures, social legislation, and programmes of adjustment. Social legislation, methods of registration, identification, restriction, and segregation of so called criminal groups. The failure of British objectives and methods. Causes and consequent of failures. Social maladjustments of the ex-criminal tribes aggravated.

The problem of the ex-criminal tribes as a heritage of British rule to Free India; neglect of these communities after independence in the Constitution; and absence of suitable State agency to deal with the problem.

The 1952 legislative measures do not solve the problem; but are only a beginning of organised social effort. Evident lack of preparation and planning to deal with the subject after legislation.

Suggested methods of rehabilitation; and the need for research, experiments, and evaluation of results of programmes.

Suggested methods :

Method 1. Rehabilitation on land in selected areas acceptable to them.

Method 2. Rehabilitation of small groups, instead of the whole community in areas suitable to them, and the occupations.

Method 3. Intensive programme of vocational training for youth.

Method 4. Partial segregation of children, and organisation of an intensive educational programme from 4 to 18 years.

Method 5. Intensive application of community organisation programme to manageable communities involving

> development of physical area, treatment of housing problem, programme of economic development preferably on a co-operative basis, provision of adequate social services for health, education, community recreation, woman and child welfare and community welfare in general, and intensive case work for maladjusted individuals.

25. Rangpur—an Out Post of Harappa Culture.

S. R. RAO, Baroda.

Rangpur is a small village 20 miles S.E. of Limdi in Jhalawar District of Saurashtra. Since 1935 it is regarded as an out-post of Harappa Culture. Recently doubts have been expressed regarding its cultural relationship with Harappa. Rangpur was again excavated in 1954 by the Central Archaeological Department to decide whether or not Rangpur had cultural or generic relationship with Harappa. As a result of the excavation two distinct cultures are noticed.

In the early period of Harappa type of pottery with Amri technique and motiff in painting is noticed. This Harappa-Amri culture survived for a longer time in a degraded form in the transition phase. A past-Harappa culture characterised by the use of a lustrous red painted ware associated in top levels with Black and Red ware of Megalithic fabric succeeded Harappa culture at Rangpur. Other antiquities like disc beads, stone weights, chert blades and copper axe found in the early cultural levels are similar to those found at Harappa. The Black and Red Ware of the sececting cultural period helps dating the two cultures. It is now possible to say that Rangpur had cultural contacts with Harappa and Amri and the post-Harappa pottery forges one more link between the Maruyan culture and the Harappa Culture.

26. "The Antiquity of the Karnatak Rock Engravings".

V. D. KRISHNASWAMI, Hyderabad-Deccan.

Pecked rock engravings in the Karnatak region have been noticed since the eighties of the last century (*i*) at Kappagallu near Bellary; (*ii*) in the Raichur doab in Hyderabad; (*iii*) on the Gombigudda Hill (Jamkhandi State) in Belgaum District; and (*iv*) at Chitaldrug in Mysore. The author has also discovered a fifth group of graffitti figures at Pattadkal near Badami in the Bijapur District. All of these, however, present a striking similarity of technique and of figures that would force anyone to study as a whole to assess their archaeological value.

Col. D. H. Gordon, in 1951, reviewed the Kappagallu graffitti and desired a fresh study of them from the point of view of their dating. A survey of the graffitti motifs observable on the boulders of the trap dyke at Kappagallu leads one to classify them as under :—

(*i*) Animal motifs pecked in outline.
(*ii*) Animal motifs pecked in outline as well as pecked all over the body.
(*iii*) Vehicle motifs.
(*iv*) Plain human motifs.
(*v*) Human sexual motifs.
(*vi*) Divine motifs.

In all these six categories the most ubiquitous technique employed appears to have been by pecking with a hammer stone of the same type of rock as the one on which the bruising is made. The figures invariably disclose that the outline has been obtained by repeated punching blows.

The evidence collected by the author, on the Kappagallu group based on pecking technique and patination of rock and subjects pecked, goes to show that the Kappagallu group as a whole is not at all pre-historic but is of a recent historic date that could not go beyond the antiquity of the Sirivaram village facing the engraved trap dyke. This tentative conclusion based on Kappagallu should be verified and amplified by detailed study of the graffitti in the Raichur doab as Captain Munn wished for and the "Gombigudda Hill" of pictures in the Jamkhandi State published by R. S. Panchamukhi. It is also necessary to find out the nature of the graffitti at Chitaldrug and its extent in space in the Chitaldrug region as, climatologically and geologically all the five groups belong to the same Karnatak plateau region.

Section X, Agricultural Sciences.

62. Binomics of *Serinetha augur* Fabr. and its association with *Dysdercus cingulatus*, the red cotton bug.

C. P. MALHOTRA, Ranchi.

Serinetha augur Fabr. is a brightly coloured bug of the family *Coreidae*. It was discovered that the bug has the curious habit of thriving on ripe stone hard seeds of Kusum (*Schleichera oleosa*) and on cotton seeds also *Kusum* is one of the major hosts of the lac insect, and from the point of the quality lac, the most important one. The bug seems to affect the germination power of *Kusum* seeds. Feeding and breeding technique and life history of the bug described. The bug displays dimorphism and cannibalistic in habits. Its association with the red cotton bug *Dysdercus cingulatus* is also discussed.

63. Loss of Vitamin A potency during the preparation of ghee from milk.

H. S. PATEL *and* B. M. PATEL, Anand.

The average loss of carotene and vitamin A in 14 trials of *ghee* making from milk of Kankrej cows was 21·0 and 30·0 per cent respectively.

Ghee making from colostral milk of Kankraj cows showed higher losses of carotene and vitamin A as compared to that from normal milk as the initial concentration of these in the colostral milk was comparatively very high.

Methods of making *ghee* have no influence in varying the losses of carotene and vitamin A. About 20 per cent vitamin A is also lost when *ghee* is prepared by indigenous method from buffalo milk.

64. Vitamin A potency of colostral milk of Kankraj cows.

H. S. PATEL *and* B. M. PATEL, Anand.

The average yield of first colostrum was 10·5 lb. with 3·2% fat having 45·7 μgm. of carotene and 285 I.U. of vitamin A per gram fat. In the next milking the average yield dropped down to 5·7 lb. and the fat percentage increased to 5·3. In the subsequent milkings the milk yield gradually increased to 8·3 lb. in the 8th milking and the fat percentage varied irregularly between 4·5 and 5·5 and the carotene and vitamin A contents decreased respectively to 7·3 μgm. and 55 I.U. per gram fat.

The secretions of total carotene and vitamin A in the first colostral milk was 3 times that in the 8th milking. However, the first colostral milk was 12 times richer in carotene and 10 times richer in vitamin A in comparison to normal herd milk.

65. Refrigerated storage of purple passion fruits (*Passiflora edulis* Sims).

J. S. PRUTHI *and* GIRDHARI LAL, Mysore.

Results of the extensive studies conducted during the last 3 years on the cold storage of purple passion fruit (Passiflora edulis, Sims) at 8 different storage temperatures viz., ranging between 32-65°F and room temperature (74-91°F) revealed the least physiological losses occur at 42-45°F and 35-38°F, the respective figures for the two temperatures at the end of 5 weeks storage being 32·69 and 34·40% in comparison to 78·38% at ordinary room temperature (74-91°F). Low temperature injury was noticed at 32-35°F, 35-38°F and to some extent at 39-42°F. The optimum storage temperature for passion fruits has, therefore, been reported to be 42-45°F (R.H. 85-90) and a storage life (as confirmed by respiration studies) of about 4-5 weeks.

Losses in the weight of fruit packed in Polyethene bags was almost negligible, while dipping the fruits in hot paraffin was prior to storage, brought the losses down to 2·5% at the end of 4 weeks' storage at 42-45°F, the comparative figures for control being 23·18%.

The causal organisms were isolated, purified and identified as *Penicillium* sp., *Aspegillus* sp., *Fusarium* sp., and *Rhizopus* sp. The pathogenicity trials revealed that these fungi have considerable deliterious effect on the physiology of the fruit, penicillium having the maximum effect. Out of the large number of available chemicals for use as preventive measures against these fungi, dipping the fruits in dilute solutions of formaldehyde (2%), Iodine (2%), Boric acid (5%) and alcohol (95%) proved to be most effective. Further, washing the crates with 2% Lysol solution prevented the attack of these microorganisms upto a storage period of 5 weeks at 42-45°F.

66. Studies on the nutritive value and utilisation of purple passion fruits (*Passiflora edulis* Sims).

J. S. PRUTHI *and* GIRDHARI LAL, Mysore.

Results of a series of investigations conducted during the last 3 years on the nutritive value, processing and utilization of purple passion fruits (*Passiflora edulis*, Sims) have been reported. The detailed analysis of the juice (comprising about 35% of the whole fruit) revealed it to be a fairly rich source of carotene (0·5 mg/100 g.) and ascorbic acid (35·0 mg/100 g). While studying the effect of regional variability, seasonal variation, plant to plant variation, etc., considerable variation was noticed with respect to the physico-chemical composition of the fruit. Employing paper chromatographic techniques, 2 organic acids (citric and malic) and 3 sugars (glucose, fructose and sucrose) have been identified in the juice. Among the carotenoids phytofluence, and β carotene have been identified. About half a dozen products have been prepared from the juice, the most promising of which are squash, cordial, pop, treacle, etc. Further, the juice makes good blends with other less acid juices like mango, apple, pineapple etc.

The peel, which hitherto constituted a big waste has been found to be a fair source of pectin (10-12% on dry wt. basis). Jam, jelly, candy, preserve and sweets have been prepared. Animal feeding trials conducted reveal that it could replace South Indian rice diet upto 20% level.

Seeds, comprising about 10-20% of the whole fruit, have been found to contain, 20-25% of semi-drying oil (iodine value = 142.0). By conducting rat feeding trials, its digestibility coefficient was found to be of the order of 97%. The oil has been refined and hydrogenated.

67. Germination trials on passion fruit seeds (*Passiflora edulis*).

J. S. PRUTHI *and* GIRDHARI LAL, Mysore.

Data are presented on the rate and percent germination of freshly extracted as well as one year old passion fruit seeds (*Passi-flora edulis*, Sims) stored at room temperative (Mysore). Figures for Fruit weight, Fruit composition, seed number, Seed weight etc., are given. Seeds were sown by randomized block system, in seed buds in triplicate, each bed containing 100 seeds in 10 rows. In the case of fresh seeds, the germination commenced within 12-15 days of the date of sowing, and was complete within another fortnight, the percent germination ranging from about 70-95% while the comparative figures for the one year old seeds were only 23-36% and their rate of germination also much slower. Soaking of seeds in hot water overright did not materially help in the rate and percent germination. The plants came to bearing in about a year. The fruit born were of very good quality. It has been indicated that passion fruit can be successfully grown under Mysore conditions

68. Effect of Pre-emergence treatment with 2·4-D on Weeds in corn and on Various soil properties.

C. H. PATHAK, Bhuj (Cutch).

Three methods of weed control in corn, namely, cultivation with a corn cultivator, close cutting of the weeds without cultivation, and pre-emergence application of 2, 4-D were compared and their effects on corn and certain soil properties were studied.

There was no significant difference in yield or date of maturity between corn on the cultivated plots and on the uncultivated but weed-free plots.

The pre-emergence application of 2, 4-D failed to control the grassy weeds and the corn yielded only 5·9 bushels per acre as compared to 38·3 and 33·8 bushels per acre in the cultivated plots and uncultivated weed-free plots respectively.

Addition of nitrogen to the pre-emergency plots at 20 pounds per acre increased the corn yield to 14·6 bushels per acre, but did not increase the weed yield. An additional 20 pounds of nitrogen per acre resulted in an increase of weed yield only.

Addition of nitrogen reduced the water content of the 2, 4-D treated corn but had no effect on the cultivated or weed-free corn.

On the uncultivated weed-free plots the pre-emergence application of 2, 4-D at 1½ pounds per acre had no injurious effect on corn.

The soil of the cultivated plots and the uncultivated weed-free plots had significantly higher nitrate contents than did the pre-emergence plots.

The soil of the uncultivated weed-feed plots had a higher nitrate content than the cultivated plots, though the difference was not significant.

The corn in the cultivated plots and the uncultivated but weed-free plots showed no deficiency of N, P, K, whereas the corn in the pre-emergence plots was deficient in all the three nutrients.

The rate of infiltration of water into the soil was the most rapid in the cultivated plots and the least rapid in the uncultivated weed-free plots, it being intermediate in the pre-emergence plots.

The average soil moisture of the soil to a depth of 18 inches was highest for the uncultivated weed-free plots and the lowest for the cultivated plots; the pre-emergence plots had an intermediate amount.

Section XI, Physiology

58. Reversed Speech and the Alpha-phoneme Theory.

C. R. SANKARAN, P. C. GANESHSUNDARAM, *and*
B. CHAITANYA DEVA, Poona.

Observations made by us on reversed speech in the light of the earlier experimental work of Tanakadate (A Study of Japanese Tone Films, Proceedings of the II International Congress of Phonetic Sciences, London, 1935, p. 117) are now re-evaluated in terms of the fresh perspectives of the alpha-phoneme and the alpha-phonoid theories, viz., that CV-VC is a constant, the consonant-vowel configuration and the vowel-consonant configuration being non-commutable (Cf. C. R. Sankaran and P. C. Ganeshsundaram, Time and Speech-structure, BDCRI, vol. 12, pp. 403-404).

59. Subclavian aortic shunt in experimental coarctation in Dogs.

T. C. GUPTA, Dharbanga.

The operation of subclavian aortic shunt in cases of coarctation of the aorta is certainly useful in cases where end to end suture of the aorta after resection of the constricted segment is not possible. Our experimental results support the conclusion of Bing and associates that subclavian aortic anastomosis conveys more blood to the lower part, thereby reducing the pressures above the coarctation.

60. Results of Fractional Gastric Analysis in Normal Indians.

J. D. PATHAK *and* M. L. PAI, Baroda.

Results of fractional Gastric analysis employing 'alcohol' meal in 31 normal adults, mostly medical students between the ages of 18-24 years are presented. The volume of fasting juice ranged between 2·5 cc. to 88 cc. with an average of 30·1 cc. Their average free and total acidity was 22·00 (±3·49) cc. and 30.53 (±3·55) cc. of N/10 acid%.

The limits of free acidity ranged from 0 to 72 cc. while these for the total acidity were between 4 to 80 cc. The incidence of achlorhydrea was 7% and of hyperchlorhydrea (i.e. above the arbitrary level of 60 cc. N/10 acid %) 9%.

The results have been compared with those of other workers in India and elsewhere.

61. Effect of pressure variations in Carotid Sinus on Intestinal movements of the adrenalin, Noradrenaline and acetyl choline.

K. SANJEEVA RAO *and* D. V. S. REDDY, Madras.

Sympathetecotomia, Vagotomia and variations in the automatic balance appear to influence the intestinal response mediated through the carotid sinus.

The sympathetic nerves and the sympatho-mimetic drugs seem to have a greater relation modify reflexly the tone and movements of the intestine, due to variation in the intrasinersual pressure, or changes in the press receptors. The parasympathetic nerves and parasympathetic drugs do not seem to exert any appreciable or significant effect in modifying the above reflexs under normal conditions.

62. A New Voluntary Muscle Relaxant.

S. K. GOSWAMI

Section III, Engineering and Metallurgy

45. Correlator Study of Nonlinear Systems.

VINCENT C. RIDEOUT, Bangalore.

Linear systems, such as amplifiers and servomechanisms have been studied for many years by measuring their gain and phase response to steady sinusoidal inputs. It is well known that complete knowledge of this response permits one to calculate the response to any other input.

In recent years, the recognition of the fact that information-bearing input signals are essentially statistical in nature has led to the study of the response of linear systems to random "noise", and to noise mixed with signals. Here, again, it is well-known that the time response of a linear system to a unit impulse is equal to the cross-correlation function of the random noise input and output.

The bewildering array of nonlinear systems now of interest to engineers presents quite a different problem from the relatively small and simple class of linear systems. The simple relationships among sinusoidal response, transient response and random noise response no longer hold. It appears, however, that response to band-limited random noise is most valuable criterion.

This paper describes how high-speech electronic differential analyzer techniques have been used to provide rapid means for measuring the cross-correlation of random noise input and output. The resultant easily-obtained curves of peak corelration and of time of peak correlation, both versus input noise power, appear to have some merit as general descriptions of the response of nonlinear systems.

46. The Methods and Uses of Electronic Analogue Computation.

VINCEN C. RIDEOUT, Bangalore.

The past ten years has brought about a great growth in types and uses of analog and digital computers. The chief impetus for this growth, as far as the analog computer is concerned, has been provided by the requirements of the aircraft industry, and the important new element in computer construction is the vacuum tube. However the uses of the analog computer have spread to many other industries, and the transistor will soon supplement the vacuum tube.

The kinds of analog computers in use to-day include such general-purpose devices as A-C Network Analyzers, Potential analysers, using liquid or paper, algebraic equation solvers, and most important of all, the various kinds of Differential Analyzers. Certain special-purpose analog computers also find considerable use to-day for chemical process controllers and gun-fire controllers.

The Electronic Differential Analyzer using d-c operational amplifiers is a particularly versatile type of computer, capable of giving solutions of practical worth to many engineering problems expressible in linear or nonlinear differential equations. This type of computer, if wide-band amplifiers are used, provides repetitive solutions which can be viewed in complete form on the cathode-ray tube, without flicker. Some sample solutions and studies show the worth of this type of computer, and indicate its proper place among other types of computing devices, such as electronic digital computers.

DISCUSSION

SECTION OF MATHEMATICS

Chairman : Dr. B. R. Seth, Kharagpur

I. Transforms and their Applications

1. Dr. B. B. Sen (Pilani) : *Stieltjes Transforms*

Iteration of the Laplace transform usually gives rise to a result which is known as Stieltjes transform. It can be identified with the integral equation which was originally considered by Stieltijes (Stieltjes, T. J. (1894), Annales de la faculte' des Sciences de Toulouse, Vol. 8, pp. 1-122) in connection with his work on continued fractions. Conversely, if the above mentioned Stieltjes integral converges, its relations with Laplace transform can also be demonstrated.

The iterated Stieltjes transform again leads to an integral equation of a very interesting type. It is also possible to obtain a new inversion of the Laplace transform by using inversion formula for the Stieltjes transform.

2. Sri Gunadhar Paria (Kharagpur) : *Transforms and their applications (Fourier).*

The main idea of the method of Transforms in boundary—and initial-value problems of Mathematical physics is that, instead of finding directly the known quantity involved in a given problem, another quantity which is the integral transform of the unknown quantity, is defined. The initial and boundary conditions are all expressed in terms of the newly defined quantity and the problem is solved for it. Then, the inverse transform gives the required quantity. In elastic problems, both isotropic and anisotropic, the Fourier transform has been widely used, particularly, in topics of the two-dimensional stress distribution in plates, bending of thin plates having various edge-conditions and resting on elastic foundations and transverse vibrations of thin plates. The Fourier integral having the infinite intervals are used when one or more of the dimensions of the medium is infinite. When the dimensions of the medium are limited, the Finite Sine transform may be used. Thus the complicated problems such as the bending of the thin ring sector plate under transverse loads may be easily solved with the help of the Sine transform.

3. Dr. Brij Mohan (Banaras) : *Mellin Transforms*

Mellin's Inversion Formula states that, under certain conditions,

if $$F(s) = \int_{0}^{\infty} x^{s-1} f(x)dx, \quad \text{then } f(x) = \frac{1}{2\pi i}\int_{c-i\infty}^{c+i\infty} x^{-s} F(s)ds.$$

The idea was first given by Riemann in 1876. But Mellin was the first writer to give an accurate discussion of the formula in 1896.

A familiar example of a pair of Mellin Transforms is

$$f(x) = e^{-x}, \qquad F(s) = \Gamma(s)$$

In 1918 Hardy gave a rigorous proof of the reciprocity theorem contained in the formula.

The formula is capable of several transformations. Several forms of the formula have been studied by Plancherel, Zygmund, Pincherle, Cauchy etc.

Every form of the formula may be used for evaluating certain definite integrals. Hundreds of definite integrals have so far been evaluated with the help of various forms of the formula.

4. SRI B. D. AGGARWALA (Kharagpur) :

The theory of integral transforms has got vast potentialities as regards its application in both pure and applied fields. When applied to solution of boundary value problems, in particular, it reduces the problem in n dimensions to one in $n-1$ dimensions generally and a successive application of it may at times, reduce the problem to the solution of an ordinary equation. Thus the main difficulty of satisfying boundary conditions is at times solved quite easily.

And in cases of bodies extending to infinity, the results may be obtained in form of infinite integral which may turn out to be integrable. A number of stress problems has been solved in this manner.

But there are cases where it does not seem to be very clear as to how to apply the transform method or what transform to apply. The cases of a clamped rectangular plate and a simply supported uniformly loaded plate with edges in the form of a parellelogram are illustrations.

At times, however, really beautiful results are obtained by transform method which would have been quite difficult otherwise. W. T. Koiter, for example, has solved the problem of a laterally loaded strip with discontinuous boundary conditions by an appeal to the theory of Wiener—Hapf type integral equations in quite an ingenious way.

5. DR. JAMIL AHMED SIDDIQUI :

The theory of transforms can be applied to solve several problems of analysis as has been shown by the works of Paley, Wicner, Curleman and S. Mandelbrogt. The speaker has shown that the following two problems can be solved with the help of the theory of Mellin & Laplace transforms:

Problem 1: Let $f(x)$ be a function infinitely differentiable in $[0, \infty)$ and such that

$$f(x) = O(e^{-B(x)})(x \to \infty). \qquad |f^{(n)}(x)| \leqslant \lambda^n M_n (n \geqslant 1) x \varepsilon [0 . \infty).$$

where $B(x) > 0$ and $\{M_n\}^{\infty}$ a sequence of positive numbers. What relationship exists between $B(x)$ and $\{M_n\}^{\infty}$?

Problem 2: Let $b\{M_n\}$ denote the class of infinitely differentiable functions on $[0, \infty)$ such that

$$|f^{(n)}(x)| \leqslant {}^{n} M_n \qquad (n \geqslant 1) \ x \varepsilon [0, \infty)$$

and let $\{\lambda_n\}^{\infty}$ be an increasing sequence of positive integers. To find a relationship between $\{M_n\}$ and $\{\lambda_n\}$ in order that $f \varepsilon b\{M_n\}$, $f^{(\lambda_n)}(0) = f(0) = 0$ should imply that $f(x) = 0$ *i.e.* the class be quasi-analytic in the generalized sense.

6. **Dr. U. N. Singh** : *Generalized Fourier Transforms (in the complex domain).*

Definition of the generalized Fourier transforms in terms of a couple of analytic functions regular respectively in the upper half and the lower half planes, as given by Carleman and proof of the generalized Fourier-theorem:

$$TSTS\,(f) \equiv f.$$

The proof of Carleman does not hold in the general case. Modification of this and application of this result to various problems in the theory of functions and harmonic analysis.

II. Non-Linear Vibrations

SECTION OF MATHEMATICS

Chairman : **Dr. B. R. Seth** (Kharagpur)

1. **Dr. B. R. Seth** (Kharagpur) :

Non-linear oscillatory systems play an important part in all branches of science and technology. Electronic methods have given us valuable information about the behaviour of such systems. Their mathematical analysis employs all the modern tools like operational methods, matrix algebra and topology. The differential equations for some of these have been studied by prominent mathematicians like Poincare, Liapounoff and Linstedt. In recent years Kryloff, Bogoliuboff, van der Pol and others have devoted quite a lot of attention to them. Van der Pol equation has been widely studied.

In most of the above cases non-linearity arises from the differential equation of the field. Non-linearlity arising from the boundary conditions exists in gravity waves which have been extensively treated by Stoker. The case when the stress-strain (or strain-velocity) relation is non-linear has not received much attention. Seth has shown that a non-linear tension-stretch law of the type

$$t = E\left[1 - \frac{1}{1+\beta s^2}\right]$$

s being the ordinary stretch and E Young's modulus, shows that the vertical oscillations of a particle attached to a light elastic thread are non-harmonic, if the amplitude is not small. In fact it is found that the displacement can be expressed in terms of elliptic functions of the second kind. The same relation shows that the differential equation for non-linear longitudinal vibrations is the same as that for long waves in a canal. Similar results hold good for vibration of a rod struck at one end or suddenly loaded. In all such cases it is found that waves cannot be propagated without change of form.

2. **Dr. D. N. Mitra** (Kharagpur) :

Problems in mechanics are practically non-linear at the outset though linearisation is adopted as an approximating device in many cases to useful purposes. Non-linear problems with one degree of freedom in which external forces are absent and which are not easily integrable are studied to an advantage by graphical method of Lienard. Geometric interpretation as an equation defining a field of directions in the x, v—plane (v denoting velocity) can lead to useful information of a qualitative character even though the solution-curves themselves cannot be obtained explicitly. Poincare's theory of singularities whether the point $v=0$ is a node, saddle, spiral or centre point developed in case of first order differential equations gives also the qualitative nature of the solution-curves and can at length be usefully employed to discuss stability. Usefulness of the above ideas is illustrated in dynamical treatment of elastic stability of a straight rod subjected to compressive forces along the axis of the rod.

3. DR. V. P. VENKATACHARI (Hyderabad—Dn.):

Practically all differential equations of Mechanics and Physics are non-linear. Linear approximations are generally used in practical applications. The scope of a non-linear problem is restricted by linearization. A few non-linear examples of practical interest governed by the differential equation

$$m\ddot{x}+p(\dot{x})+f(x) = F\cos wt \quad \text{are given}$$

Some analytical methods of solution of non-linear problems are discussed with special reference to the contributions made by Russian Mathematicians.

4. DR. G. BANDYOPADHYAY (Kharagpur): *Orbital Stability of Non-linear vibrations*

The investigations of the variational equation of a non-linear system always leads to the Hill's equation and the solution of this equation is defined (in a narrow sense) to be stable when they are bounded. The investigations regarding the nature of the solutions of Hill's equation depends on the Floquet theory of linear equation with periodic coefficients. It appears at the first sight that the investigation of stability of the variational equation decides completely the question of stability of the system. This, however, is not the case; because the boundedness of difference of the displacements of the disturbed and undisturbed motions *compared at the same time* is not the criterion of stability. Stability may be defined in terms of establishing correspondence between the disturbed and undisturbed motions in such a fashion that time plays no essential role in it. Such a stability is called Orbital Stability (the term being borrowed from Astronomy) and has a more elaborate method of investigation.

III. Absolute Summability of Series

SECTION OF MATHEMATICS

Chairman: DR. B. R. SETH (Kharagpur)

1. DR. B. N. PRASAD (Allahabad):

2. Dr. T. PATI: *Absolute Riesz Summability*

The theory of Riesz summability by 'typical means' and its special applicability to problems concerning the behaviour of Dirichlet series, whose convergence or divergence, is, in general, of a much more delicate character than that of power series, had already become quite familiar when the notion of absolute Riesz summability was introduced by Obrechokoff (Math, Zeitschrift, 30, 1929). If λ_n be a positive, monotonic increasing function of n, steadily tending to infinity with n, and

$$A_\lambda(\omega) = A_\lambda{}^0(\omega) = \sum_{\lambda_n \leqslant \omega} a_n\,;\; A^r{}_\lambda(\omega) = \sum_{\lambda_n \leqslant \omega} (\omega-\lambda_n)^r a_n,\; r > 0,$$

then $R^r{}_\lambda(\omega) = A^r{}_\lambda(\omega)/\omega^r$ is called the Riesz mean of 'type' λ and 'order' r of the infinite series Σa_n. If $R^r{}_\lambda(\omega) \varepsilon\, BV(A,\infty)$, that is, if $R^r{}_\lambda(\omega)$ is a function of bounded variation in (A, ∞), where A is a finite positive number, the series Σa_n is said to be absolutely summable (R, λ, r) or summable $|R, \lambda, r|$. By definition summability $|R, \lambda, 0|$ is equivalent to absolute convergence. As in the case of ordinary Riesz summability so also for absolute Riesz summability we expect a reasonable upper limit to the rate of increase of the type to ensure the effectiveness of the method. In this direction Mohanty(Proc. London Math. Soc. (2), 52, 1951) has proved that summability $|R, e^n, 1|$ is equivalent to absolute convergence by making use of discrete Riesz means after Hardy. The equivalence of summability $|C, k|$ and $|R, n, k|$ was demonstrated by Hyslop (Proc. Edin. Math. Soc. (2), 1936). The problem of determining the conditions for the absolute equivalence of two processes of Risez summability defined by different types and orders seems to have remained unsolved so far, and affords a fruitful line of investigation.

While absolute convergence implies summability $|R. \lambda\ k|$, $k > 0$, the converse is not necessarily true. It is of interest to see what Tauberian conditions may be imposed upon the nature of a given infinite series such that its summability $|R, \lambda\ k|$, may imply its absolute convergence. The following Tauberian theorem has recently been established by Pati(Math. Zeitschrift, 1954).

If Σa_n is summable $|R, \lambda, k|$, $k > 0$, $\{a_n\lambda_n/(\lambda_n-\lambda_{n-1})\}$is a sequence of bounded variation and $\{\lambda_n/\lambda_{n+1}\}$ is a sequence of bounded variation, then Σa_n is absolutely convergent.

There however, still remains considerable scope of investigation in the domain of Tauberian theorems.

The 'first theorem of consistency' for absolute Riesz summability due to Obrechkoff (loc. cit.) amounts to the assertion that the effectiveness of an absolute Riesz summability process increases with the order if the type remains unaltered. There arises the natural question as to whether anything can be said about the relative effectiveness of any two processes of absolute Riesz summability of which the types are different while the orders are identical. By way of answering this question Chandra-sekharan (Jour. Indian Math. Soc. N. S., 6, 1942) proved the direct analogue of Hardy's well known extension of the classical 'second theorem of consistency' assuming one of the types to be a very special kind of logarithmico-exponential function of the other. Recently Pati (Quarterly Jour. Math. Oxford, 1954) has established the following very general theorem which extends the scope of applicability of the second theorem of consistency and includes Chandrasekharan's results as a particular case.

If $\varphi(+)$ is a non-negative monotonic increasing function of t for $t \geqslant 0$, steadily tending to infinity as t tends to infinity such that, for positive integral k, $\varphi(t)$ is a $(k-1)$ th indefinite integral for $t \geqslant 0$, and $t^r\varphi^{(r)}(t)/\varphi(t) \varepsilon BV(h, \infty)$ $(r = 1, 2, .., k)$, where h is a finite positive number then any infinite series which is summable $|R, \lambda_n), k|$ is also summable $|R. \varphi(\lambda_n), k|$.

More recently still Prasad and Pati have obtained a supplementary theorem for the case in which the order is positive and non-integral, assuming that $\varphi^{(1)}(t)$ is monotonic increasing.

Obrechkoff (loc. cit.) was the first to investigate into the absolute Riesz summability of Dirichlet series. He obtained results regarding the asymptotic behaviour of the sum function of Dirichlet series to the right of the line of absolute summability. Results connecting the abscissae of ordinary and absolute Riesz summability of Dirichlet series have been obtained by Bosanquet (Jour. London Math. Soc., 22, 1947 & 23, 1948) and Austin (Jour. London Math. Soc., 27, 1952). A recent result of Tatchell (Jour. London

Math. Soc., 29, 1954) analogous to a well known theorem of Hardy an Riesz has led him to the conclusion that the abscissae of absolute summability, whether finite or infinite, corresponding to the methods $|R, \lambda_n, k|$ and $|R, e^{\lambda_n}, k|$ are identical for every Dirichlet series $\Sigma a_n e^{-\lambda_n s}$. There seems to be much room for research on the problem of absolute Riesz summability of the Dirichlet product of any two summable series.

Concerning the absolute Riesz summability of Fourier series, its conjugate series and their derived series Mohanty (loc. cit.) has obtained. a series of theorems. One of his theorems (Proc. London. Math. Soc., (2), 51, 1949, Theorem B) in conjunction with the special case of the Tauberian theorem of Pati, for $k=1$, has led to the formulation of a criterion for the absolute convergence of Fourier series analogous to the well known Hardy-Littlewood criterion for the convergence of Fourier series. The most general results on the absolute Riesz summability of the rapidly increasing type $\exp\{(\log n)^{1+1/\alpha}\}$, $\alpha \geqslant 1$, including as particular cases previous results of Mohanty (Theorems 4, 6, 7 & 8, Proc. London Math. Soc., (2), 52, 1951) and Pati (Bull. Calcutta Math. Soc., 44, 1952; Trans. Amer. Math. Soc., 1954) have been announced in the abstract of a paper "On the absolute Riesz summability of Fourier series etc.", recorded in the proceedings of the current session of the Indian Science Congress. Pati has obtained a result regarding the absolute Riesz summability of the series $\Sigma(-1)^n n^\rho$ which goes deeper than the hitherto known result on its absolute Cesaro summability (Hyslop : Proc. London Math. Soc., 46, 1940). Mohanty (Jour. London Math Soc., 25, 1950) has shown that summability $|R, \log n, 1|$ is a non-local property for Fourier series. Results concerning the absolute Riesz logarithmic summability of Fourier series are due to Izumi and Kawata (Tôhoku Math. Jour. 45, 1938), Izumi and Matsuyama (Math. Jap., 1, 1949) and Prasad and Misra (40th Indian Science Congress, IV).

3. Mr. S. N. Bhatt (Allahabad): *Absolute summability factors*

Given a sequence $\{\lambda_n\}$, if a series $\Sigma\lambda_n a_n$ is absolutely summable in some sense, while in general Σa_n is itself not so summable, then λ_n is said to be an absolute summability factor of the series Σa_n.

In 1925 Kogbetliantz (Bull. des Sc. Math.(2), 49, 1925) proved that if Σa_n is summable $|C, \delta|$, $\delta > 0$, then the series $\Sigma a_n/n^\gamma$, $0 \leqslant \gamma \leqslant \delta$, is summable $|C, \delta-\gamma|$. The restriction $\gamma \leqslant \delta$ was relaxed by Sunochi (Jour. Math. Soc. Japan. 1, 1949).

The first application of absolute summability factors to special infinite series is due to Prasad (Proc. London Math. Soc.(2), 35, 1933) who established that for a Fourier series

$$(1) \qquad \tfrac{1}{2}a_0 + \sum_1^\infty (a_n \cos nt + b_n \sin nt) = C_0 + \sum_1^\infty C_n(t)$$

if $\{\lambda_n\}$ be any one of the sequence:

$$(2) \qquad \frac{1}{(\log n)^{1+\varepsilon}}, \frac{1}{\log n\,(\log \log n)^{1+\varepsilon}}, \ldots, \frac{1}{\log n \ldots (\log \log \ldots \log_p n)^{1+\varepsilon}}, \varepsilon > 0,$$

then the series $\Sigma\lambda_n c_n(t)$ is summable $|A|$ for almost all values of t. Prasad also proved a parallel theorem for conjugate series. Izumi Kawata (Proc. Imperial Acad. Tokyo, 40, 1938) proved that Prasad's result holds even when we replace the sequence of summability factors by the more general sequence $\{\lambda_n\}$ where $\{\lambda_n\}$ is convex and such that $\Sigma n^{-1}\lambda_n$ is convergent. Chow (Jour. London Math. Soc., 16, 1941) established that for such a sequence $\{\lambda_n\}$ the series $\Sigma\lambda_n c_n(t)$ is summable $|C, 1|$ for almost all values of t. He based the proof of his theorem on a result of J. Marcinkiewicz (Jour. London Math. Soc., 40, 1939) concerning the strong summability of Fourier series. The set of points at which his result holds, is, therefore, not necessarily the Lebesgue set in which Prasad's result hods. Later Cheng (Duke Math. Jour. 15, 1948) proved that if $\{\lambda_n\}$ be any one of sequences (2) the series $\Sigma\lambda_n c_n(t)$ is summable $|C, \alpha|$, $\alpha > 1$, in the Lebesgue set. Pati (Duke Math. Jour., 21, 1954) has very recently generalised all these previous results by replacing the sequences (2) in Cheng's theorem by the more general class of summability factors $\{\lambda_n\}$ where $\{\lambda_n\}$ is a convex sequence such that $\Sigma n^{-1}\lambda_n$ is convergent. He has also obtained the result that if an infinite series Σa_n is strongly summable $[C, 1]$ and $\{\lambda_n\}$ is a convex sequence such that $\Sigma n^{-1} \lambda_n$ is convergent then $\Sigma\lambda_n a_n$ is summable $|C, 1|$. Prasad and Bhatt (volume of Abstracts, Proceedings of the current session of the Indian Science Congress) have carried this line of investigation still further and have also deduced Cheng's theorem on the absolute summability of $\Sigma c_n(t)/(log\ n)^{1+\varepsilon}$ (Duke Math. Jour., 15, 1948) by an application of a theorem of Pati (loc. cit.) Theorem 2).

By way of answering the question as to what necessary and sufficient conditions should be satisfied by a sequence $\{\lambda_n\}$ in order that the series $\Sigma\lambda_n a_n$ may be absolutely summable in the Cesaro sense of a given order whenever Σa_n is absolutely summable in the Cesaro sense of a certain order Bosanquet (Jour. London Math. Soc. 1945, vol. 20) has established a class of theorems.

Tatchell (Jour. London Math. Soc., 29, 1954) has recently obtained the analogue for absolute summability of a well known theorem of Hardy and Riesz (Theorem 20, The General Theory of Dirichlet's Series, Cambridge, 1952) which includes as a particular case a previous theorem of Mohanty (Jour. London Math. Soc., 25, 1950).

Chow has recently obtained a number of interesting results concerning absolute summability factors of power series on the circle of convergence (Proc. London Math. Soc., (3), 1, 1951; Jour. London Math. Soc., 26, 1951; Quarterly Jour. Math. Oxford, 1953.)

4. Dr. M. L. Misra (Saugar) : *On Absolute Summability (A) of Fourier Series and its Conjugate Series.*

A series Σa_n is said to be *absolutely summable* (A), or summable $|A|$, if $f(x) = \Sigma a_n x^n$ is convergent in $(0 \leqslant x < 1)$ and if $f(x)$ is of bounded variation in $(0, 1)$, and then the sum s $\lim_{x \to 1-0} f(x)$. Thus a series which is absolutely summable (A) is necessarily summable (A), but the converse is not true. The notion of absolute summability (A) was introduced in 1929 by J. M. Whittaker who also proved the consistency condition that every absolutely convergent series is absolutely summable (A). Fekete, in 1932, proved that summability $|C, r|$, r being a positive integer, implies summability $|A|$. Littlewood gave an example to show that a series may be convergent at a point without being summable $|A|$ at that point, while B. N. Prasad showed that a series may be summable $|A|$ without being necessarily convergent.

Whittaker proved in 1929 that every Fourier series which converges under Dini's condition is summable $|A|$. Shortly after, Prasad made a thorough and detailed investigation of the summability $|A|$ of Fourier series and obtained a series of important results. He also examined for the first time the summability $|A|$ of the conjugate series. He generalised the result of Whittaker and also proved that a series which converges under Jordan's condition is summable $|A|$. This result was extended by M. L. Misra who proved that a series which converges in virtue of de la Vallee-Poussin's condition is summable $|A|$. Latter on, Bosanquet extended these results by proving that if $\phi_\alpha(t)$, $\alpha \geqslant 0$, the Riemann-Liouville fractional integral mean of $\phi(t)$, is of bounded variation in $(0, \delta)$ and tends to zero as $t \to 0$, then the Fourier series is summable $|A|$. Bosanquet and Hyslop proved that the conjugate series is summable $|A|$ if $\int_0^\delta |\psi_\alpha(t)| t^{-1} dt < \infty$, $\psi_\alpha(t)$ being the mean of order α of $\psi(t) = f(x+t) - f(x-t)$. The summability (A) of th conjugate series was also examined by Takahasi and Kuniyeda.

In order to investigate the bounded variation and behaviours of a complex power series on its radius and circle of convergence, Prasad discussed the summability $|A|$ of Young's Restricted Fourier series and proved that in the interval of restriction the Restricted Fourier series of the second class behaves as the ordinary Fourier series for pruposes of summability $|A|$. Misra proved that the same is true for R. F. series whatever be their class.

Absolute summability (A) factors have been obtained by Prasad, Izumi, Kewata and Chow. Kuniyeda & P. L. Bhatnagar have considered summability $|A|$ of the derived Fourier series and conjugate series. Hyslop has proved a Tauberian theorem for summability $|A|$.

Since summability $|C|$ implies summability $|A|$, the results obtained for summability $|C|$ of the Fourier series and conjugate series are also true for summability $|A|$.

5. Dr. R. Mohanty: *Absolute Summability(C)*

6. Dr. U. N. Singh: *Absolute Summability Functions*

IV. Teaching of Mathematics in Engineering Institutions

SECTION OF MATHEMATICS

Chairman: Dr. B. R. Seth (Kharagpur):

1. Dr. B. R. Seth (Kharagpur):

In the last seven years a number of engineering colleges and technological institutions have been started in the country to cater to the pressing needs of various development projects. The young men have responded and now some of the best of them, instead of seeking clerical and administrative jobs are very anxious to get trained in various branches of engineering. Most of the engineering colleges get applications of which only about ten per cent can be taken. Last year the Indian Institute of Technology received about three thousand applications, of which only about 300 could be taken. It is high time more such institutions are founded so that youthful energy now available can be harnessed in the best interests of the nation.

In the past the engineering institutions taught mathematics in an indifferent fashion. It was considered a bad formal necessity, with the result that the engineer on taking his degree hardly even knew how to use the very elementary tools of the subject. But the big technological advances made in America with the help of mathematics have convinced all concerned that it should be taken more seriously. In fact it has come to play a vital role in all basic research leading to technological advance. An extra responsibility, however unwanted, has fallen on the shoulders of the mathematician, and it is now for him to prove himself equal to the task.

Many reports have been published in America and England on the teaching of mathematics to engineers at all levels. It is suggested that the Section of Mathematics of the Indian Science Congress in collaboration with the Sections of Statistics and Engineering should set up a sub-committee to study this problem and submit its report at the next session. It can consider both the topics and the standard to which mathematics be taught at all levels in Engineering institutions. Particular attention may be paid to the part it should play in high grade technological institutions where research will play a dominant role.

2. Dr. A. K. Gayen (Kharagpur) : *Teaching of Statistics in Technological and Engineering Iastitutes.*

Statistics of a special kind is important for many professions and should find adequate place in teaching programmes of Universities and Technological or Engineering Institutes. Mathematics and Mechanics remain as ever to be essential prerequisites for students of Engineering Sciences. But time has come now when want of teachers in Statistical theory in any technological institute will be considered as much an anomaly as the absence of teaching arrangements for mathematics and mechanics. Rapid developments are taking place in statistics and its application in quantitative experiments of general sciences and engineering. Many physical and chemical theories are basically statistical. Theory of probability and statistics is being applied in routine control and factory operations. Sooner or later in his career a scientist or Research Engineer is almost certain to feel for the need of use of statistical methods and it is good that he should adopt the right approach from the start than to wait until later years. Earlier introduction to statistics in the curriculum of studies in Colleges of Sciences and Engineering would as such prove to be highly beneficial. Suitable courses for various fields of applications may be offered in places such as technological institutes. It should however be noted that not many of the students will become practising statisticians and the aim should therefore be to teach students to recognise a statistical problem in the given field of application, to know what kind of solution is possible and to understand the solutions. There will be room for lessons in statistics as an 'option' and this is in line with the developments that are taking place. Some fundamentals of Probability and Statistics should however be taught along with the compulsory courses of mathematics. In other countries attempts are being made for the introduction of suitable syllabi for statistics in vocational training centers and even in the top classes of Grammar schools.

3. Sri A. K. Chaudhuri (Kharagpur) : *Course in Statistical Quality Control in Technogical Education.*

In this age of Industrialisation and development the methods of statistical quality control are found to be indispensible tools in the hands of engineers and industrial workers. The statistical quality-control methods are comprised of the different techniques of applied statistics and the theory of probabitity—especially as applied to industry in all its three phases of Research, production and Inspection. It has been decisively established in U.S.A., UK. and other countries that the techniques of Statistical Quality-Control provide almost sure guide in matters of policies of production and management towards the most efficient and economic production with improvement in quality at lower cost. Due to these reasons, it is being strongly felt that engineers may he be connected with research or production or management should be throughly acquainted with the most important principles of applied Statistics and probability with special reference to their practical applications. This can be achieved by introducing courses in "Statistical Quality-Control' methods in the curriculum of study for a Bachelor's degree of Engineering, the syllabii being suitably oriented to meet the special need of the country. Proper personnel for this purpose should also be raised by selecting a band of people with proper outlook and giving them intensive training in suitable Industries and organisations at home and abroad so that they can be entrusted with teaching in this branch in technological Institutes.

4, Dr. V. P. Venkatachari (Hyderabad-Dn):

It is proposed to deal with the following aspects.

1. Relationship between Mathematical concepts and Engineering problems.
2. The importance of approximations in the practical solutions of Engineering Problems.
3. Non-linear problems in the Engineering Science.

5. Dr. C. Prasad (Roorki): *Mathematics for a Post-graduate course in Engineering.*

A post-graduate course in engineering should equip the student for understanding advanced work being done in any special branch and for further research. As such a knowledge of higher Mathematics becomes essential. For example, a knowledge of functions like Bessel or Legendre, solution of more common partial differential equations, theory of complex numbers, etc. should form a part of the Mathematics syllabus in a post-graduate course. In how much detail they are done will have to depend upon the time available.

Besides this general course, a special duty of the mathematical theory involved in the particular course should be made. Thus for a course in structures relevant portions from the theory of elasticity may be done.

6. Prof. B. D. Puri (New Delhi): *Teaching of Mathematics and Statistics in Engineering Institutes.*

It is necessary that Higher Mathematics should be taught to all Engineering Students who intend to specialise in any particular branch of Engineering. It is not necessary that students of ordinary courses should learn Higher Mathematics which should be taught by teachers of subjects in which it is needed for specialised courses and research problems. The personnel available in our country for research in Engineering subjects is very meagre and something should be done to produce research students even if it is by introducing subjects of Statistics and Higher Mathematics.

7. Dr. K. C. Chakko (Aligarh):

The existing syllabuses in Engineering and other subjects in Engineering Institutions cover too wide a ground and are not specially helpful for research or postgraduate work. These have to be considerably curtailed in order to introduce the new principles of mathematics and other basic knowledge required for future Engineers. It is not at present possible to provide entirely new batch of research Engineers starting from the Intermediate Arts or Science standard because of the cost. It is more practicable to train the best of the engineering graduates from existing Engineering Colleges by putting them in a few post graduate institutions under well qualified teachers.

8. DR. S. V. CHANDRASHEKHAR AIYA (Poona).

1. Make students mathematically minded
2. Develop art of thinking
3. Examples from actual engineering problem.
4. Need to teach limitation of mathematics and use of approximations
5. Postgraduate teaching to be done by tutorials & discussion
6. Mathematics taught must be actually used in the teaching of engineering.

Engineers & Mathematicians must meet and discuss each other's problems.

9. PROF. A. M. SENGUPTA (Howrah): *Teaching of Mathematics in Engineering Institutions.*

I want to say a few words about the defects in the Mathematical training of the students of Engineering in our country. This in mainly due to the defects prevalent in the syllabus of Mathematics for Engineers. The syllabus of Mathematics, even now, is more or less the same as that followed during the British rule. That syllabus is usually framed without any reference to actual needs and interest in the subject of the Engineering students, the result is that the students lack the knowledge and grasp of fundamental principles, which knowledge is essential for the cultivation of constructive and independent thinking as also of the ability to tackle practical engineering problems.

As regards the needs and interest—an Engineer is interested primarily in the application of Mathematics to the solution of problems. He wants to know how each piece of mathematical theory can be utilized in his work. And so the Engineers' approach to a mathematical concept or theory is different from that of the mathematicians. Further an Engineer is often interested in an approximate solution of his problem, specially when exact solution is complicated.

As regards needs—with the rapid advancement of engineering sciences, the complexity in engineering problems is growing faster—complexity arises from the necessity of including more and more factors in the solutions. Consequently use of mathematics in Engineering has increased to a tremendously great extent. There is few fundamental concept or theory of mathematics which has not the demand or which is not needed by Engineers to be used in the development of one or other of the various engineering sciences. But then, we cannot include everything in our curriculum.

We must bear in mind the limitation of available time.

The development of reasoning power requires time. Further, in our country, even now, in Engineering Institutions mathematics is generally considered a side subject and use of mathematics is looked upon as a tool. Even distinction is made in the cadre of a teacher of mathematics and physics (non-technical subjects) and a teacher of engineering (technical subjects). While in scientifically advanced and industrially developed countries—to quote from the official register of Harvard University "the border line between the engineer an applied scientist is becoming dimmed".

With the interest and needs of engineering students as also the limitations of the available time constantly in mind, it is high time, though late, to chalk out a course of mathematics on the basis of a reasonable number of fundamental principles having broad and wide applications in engineering sciences and with emphasis on the technique of application rather than on the mathematical theory.

Before I conclude, I like to note that no emphasis is laid in our country on the various numerical methods of solving engineering problems. That is, the strong-arm method, as it is termed by Dril Pickett, one of the Guest Professors from Wisconsin University, as it provides broad and wide application and offer great facilities for dealing with the new complexities in practical engineering problems which are in practice set by situations, machines and nature.

Finally, we must not forget that we are in a different era. And to quote from Harvard University official register "An Engineering curriculum should centre on the imparting of broad and widely applicable principles of analysis and synthesis.

1C. Dr. Alfred C. Ingersoll (U.S.A.): *Teaching of Mathematics for Engineers at the California Institute of Technology.*

At Caltech we receive the incoming student at about the level of your matriculation, that is at the age of 16 or 17 years. In the following 4 years, then, we can not hope to produce a finished professional engineer, or even a journeyman. The best we can hope to do is to produce an apprentice with a good kit of tools. Mathematics is fundamental in the kit and we require the following of all our engineering students:

1st and 2nd year: (taught in math. dept.) Differential and Integral Calculus, Analysis and Ordinary Differential Equations.

3rd year: (taught in engineering dept.) Vector analysis with application to fluid flow, heat flow and electrostatics. Ordinary differential equations with series solutions, boundary value problems and Orthogonal functions, Bessel functions, Fourier series, Lagendre polynomials. These are all subsequently applied to the solution of partial differential equations of physics, such as vibration of string, beam or membrane, fluid flow, heat flow, soil drying and consolidation.

In the last term of the 3rd year the student can select between complex variable and statistics. We feel statistics is important especially for the civil engineer in connection with hydrology problems of rainfall and flood frequency analyses.

11. Prof. M. K. Ganguli (Poona):

The speaker attempted to focus attention as to how Mathematics and Statistics come as an aid for solving various engineering problems. Generally before recommending any unconventional designs in any engineering problems the performance of the proposed design is investigated by different experimental techniques. The techniques have got certain merits and demerits and it is always found desirable in such cases to make an analytical approach for a complete solution, if possible, which in turn greatly increases confidence in the results. Though on many occasions the exact solution of the many unknowns involved in the problems cannot be obtained but a very good approximation of the same will generally be available. Statistics as a science of approxi, mation steps in here to render help.

With the help of certain illustration, speaker demonstrated how and when these approximations can be made. Numerical analysis as a powerful tool was thus shown necessary for every day working of the engineers and it is to be hoped, the speaker, remarked this particular branch of mathematics and statistics will find a prominent place in the teaching syllabus for the engineering course.

SECTION OF STATISTICS

CHAIRMAN : DR. V. G. PANSE (New Delhi)

Problems of Co-Ordination of Statistical Activities

1. P. V. SUKHATE (New Delhi)

1. DR. P. V. SUKHATME (New Delhi) opened the symposium by referring to how coordination is effected in the U.N. system of official Statistics. He surveyed the present state of co-ordination in India and discussed the various problems it has raised. He also referred to co-ordination in research in mathematical and applied statistics. In the course of his speech he made the following points.

(a) The U.N. system is a decentralised system in which the specialised agencies collect statistics in their respective fields from member nations.

(b) Co-ordination is confined to the work of standardising concepts and definitions and is the responsibility of the specialised agencies in their respective fields.

(c) Co-ordination among the specialised agencies is brought about through a Committee on co-ordination whose Chairman is the Director of the U.N. statistical office. It is confined to collecting statistics not collected by the specialised agencies and publishing an abstract covering all fields.

(d) The application of the U.N. statistical system to conditions in India needs modification to bring it in line with the federal structure of the Government and the division of responsibilities between the centre and the states.

(e) Indian system is going through large and rapid changes. It is decentralised at the centre. Co-ordination is brought about by C.S.O. (Central Statistical Organisation) & N.S.S. (National Sample Survey).

(f) The field of co-ordination of C.S.O. extends to (i) vetting proposals from Ministries and (ii) publication of an overall abstract of statistics; but it is believed that it will be further extended to cover other fields like recruitment, training, advising state Governments etc.

(g) Co-ordination to be effective requires impersonal, impartial and humble attitude. It is therefore important for the CSO to avoid giving impression that it is a controlling body sitting in judgement as it were on the proposals of the Ministries. CSO must also not be a competing office. These requirements are best met if the responsibility for co-ordination in individual fields is as in the U.N. system left to the Ministries concerned to be carried out in consultation with the states and simultaneous consultation with the CSO.

(h) The N.S.S. constitutes another co-ordinating machinery at the centre. It is set up to collect statistics from the primary source in all fields on a continuing basis. It means that the states' responsibility of collecting statistics from the primary source, even in the field of current statistics is being duplicated by the centre.

(i) The control at present excercised over the Ministries by the CSO and the encroachment of NSS on the primary function of the states are a pointer to a swing in favour of strong centralisation.

(j) In giving consideration to research statistics, it is important to recognise that statistical method is a tool and cannot be divorced from its field of application. Thus research statistics in agriculture must be the field of the I.C.A.R.

(k) There is an urgent need to work out the requirements in terms of men and money, of research statistics, for the centre and its counter-parts in the states. There is of course ICAR statistics branch to co-ordinate statistics in agricultural research but the money spent is negligible. There is need for a similar organisation, attached to CSIR.

(l) Research in mathematical statistics is the function of the Universities but little has been done to co-ordinate their activities.

(m) Research and training in applied statistics seems, with exception of agriculture, all centralised in one Institute. There is therefore a danger that other Institutes may not get resources to develop.

(n) Co-ordination presumes fair distribution and decentralisation of work. The problem is basic and debated with heat everywhere. Its solution demands vigilance on the part of statisticians at all time.

2. DR. K. S. RAO (Bombay)

The main demand for collection and presentation of data is for aiding decisions arising in economic policy and planning. The decisions may be those of individuals, corporate bodies or governments, central and state. The best decision in any case depends on the extent of operational freedom available to the decision making body. The frame work within which such freedom is available changes from time to time. It is a peculiarity of the economic phenomena that while the frame work influences the best decision, the decision taken again influences the frame. The state of an economy, for example, determines the economic policy of the government and the policy adopted influences the state of the economy.

For making a decision it is not necessary that details about all the minute aspects of the frame should be known. Since economic variables are highly interrelated, in the presence of a few relevant factors others provide no appreciable explanation. It is therefore a fortunate circumstance in quantitative economics that a study of a few relevant variables constitutes almost a study of the entire frame within which a decision is to be made. But since these variables are interrelated, the decision is to be based on a model which recognises explicitly the interrelated nature of the variables. Any neglect of this precaution does not lead to an optimal decision.

The estimation and use of economic models for economic policy depend on the approximation permitted in the closeness of fit required between a model and data and and on the techniques of statistical inference available. It is with the help of such techniques that we can identify an optimal decision.

If the economic decisions at a time or sequence of time points of the central government or of state governments, for example, are unco-ordinated, each decision may be identified as the best both from the point of the specification and estimation of the model used. But taken together they need not represent the best set of optimal decisions. On the other hand they may be mutually contradictory to one another. This will arise because of lack of indepedence between the frames within which decisions are made and between the statistical tests used for identifying optimal decisions within each sector.

Economic design: From the foregoing it is evident that there must be a comprehensive economic design for the collection, analysis and interpretation of data to meet the needs of a coordinated economic policy.

An economic design depends essentially on the objectives of economic policy. The targets of economic policy lead to a search of instruments for attaining them. A study of the interrelationships between targets and instruments is in terms of economic models. They must be formulated in a form identifiable by actual data. The study of models can be made in terms of only data that are available or can be collected. The form in which the data are to be collected is determined by the form in which the models are required. It is thus ultimately the objectives of economic policy and economic decicisons in general that determine the economic design for the collection and use of data.

Statistical design: While the nature of data to be collected is a matter for economic design, the extent to which they should be collected and the method of collection is a matter for statistical design. Whether they should be collected in the form of time series or whether they should relate to one interval of time or whether they should be collected by complete enumeration or by sampling and if so by what procedure of sampling and size of sample, are all matters for statistical design. Statistical design depends on the statistical techniques of collection and interpretation and the precision with which the statistical techniques enable the measurement of economic relation with the existing machinery for economic administration of the country.

3. Dr. A. R. Sen (Lucknow)

The real problem of co-ordination of statistical activities arises in decentralised statistical systems. The main function of a co-ordinating agency is to develop a certain degree of uniformity and comparability in concepts and terminology in the different subject matter fields with a view to increase the over-all efficiency of the decentralised statistical systems.

Some of the specific functions of a central co-ordinating agency were outlined and satisfaction expressed at the progress made in this direction at the two Joint Conferences of Central and State Statisticians held in New Delhi during 1951 and 1953. A research unit in each State and at the Centre similar to the Indian Council of agricultural Research is needed for proper co-ordination of research in connection with planning and conduct of surveys.

The functions of a co-ordinating agency should be restricted to co-ordination of statistical activities only and the agency should not have administrative control over the statistical offices of the decentralised systems. The speaker warned against the danger of reducing the standard of State statistics for the sake of All India comparability.

4. Dr. P. K. Bose (Calcutta)

Statistical activities are mainly of three types—(1) compilation of data, (2) use of statistics as a tool and (3) teaching and research. Co-ordination in its proper sense should be effected at each level. Some progress has been made in this direction sofar as activities of first type are concerned, by the establishment of the Central Statistical Organisation. and also a little at the second level, e.g. some uniformity of agricultural experimental designs and analysis has been achieved by the I.C.A.R. There is, however, practically no co-ordination in teaching and research and the need is urgent that standardisation of syllabi and courses of study be taken up. It is important to note that the tendency for centralisation and monopolisation is harmful to any effective scheme for co-ordination.

5. Besides the above speakers, Drs. D. V. Rajlakshanam, N. K. Bose, A. K. Gayen and Messrs T. Ghosh, K. C. Basack and K. C. Chanda also participated in the discussion.

6. In concluding the discussion, the Chairman remarked that the need for co-ordination was agreed on all hands. The problem was how to achieve it. Any scheme for co-ordination that is imposed from the top is not likely to succeed, but what is needed is a co-operative attitude and development of healthy conventions as one goes ahead. As an example of co-ordinated efforts he cited the Farm Management Surveys under the Planning Commission where the State organisations worked independently, but they met together to formulate a uniform programme of work, to discuss the progress made and so on. He further observed that in the initial stages of co-ordination some duplication of work might be allowed, and this might be put to advantage by trying to extract that amount of information which is revealed only from the comparison of the different results. He also emphasized the need of co-ordination in Universities. He suggested that the University Departments of Statistics should attach to themselves some branches of applied work, which would help directing their study and research to practical problems.

Demographic Problems

1. Dr. U. S. Nair (Travancore)

Opened the discussion. He defined the scope of demography as comprising not merely statistics of births, deaths, etc. depicting the condition of the population but covering all things relating to social, economic and cultural activities of different groups of people in the population. Accordingly problems of demography may be studied under four broad heads: growth, distribution, social aspects and cultural aspects. He confined himself to discussion of problem of growth so far as his state, Travancore was concerned. But he presumed that the points he would make out would have a wider field of applicability. In order to study growth of population one must have statistics of births, deaths and migration besides a census of population. In India, and particularly in his own state, birth and death registers are very inadequate, and there was need for collecting such data by sample survey. Then Dr. Nair referred to one result coming out of the analysis of birth statistics, namely that number of first born children to mothers with ages above twenty was considerably less than to mothers aged less than 20 years. This seems to suggest that increase in the age of marriage to twenty may have significant effect on population control. He next discussed the result of analysing the number of births recorded for mothers who take fish and those who do not take fish. The conclusion appears to be that fish-eating (and perhaps protein intake in general) has the effect of increasing the rate of reproduction.

2. Prof. N. K. Bose (Calcutta)

Anthropologists realise the great need of more intimate co-operation with Statisticians.

There are various productive organisations prevalent in different parts of India to-day: hunting and collecting with axe cultivation; agriculture by means of the plough for local consumption coupled with village industries run by human or animal power, commercialized agriculture coupled with mill industries, and so on. It would help anthropologists immensely if demographers could find out the carrying capacity of each system of production per square mile of land, taking a certain standard of living as the common point of reference.

A word of caution is needed here. When it is claimed that the present industrial system supports more people per square mile at a high standard, this is often calculated on the basis of the area of residence (or occupied area). Actually such a group may draw their requirements from vast stretches of land like Africa, Argentina or Australia. While calculating the carrying capacity, it is imperative that these additional areas should also be taken into adequate consideration.

We know little about the net reproductive indexes of various strands of the Indian population. It is usual to lump together all classes in India while calculating things like average expectancy of life and so on. It is suggested that the different strands of the Indian population should be treated separately for such purposes. In this preliminary analysis of the population, anthropologists can be of some service to demographers.

With regard to the question of birth-control, attention may be drawn to the work of Dr. S. N. Sanyal (Calcutta) as well as of others in connection with the oral administration of either compounds which are anti-vitamin E in their function, or which physiologically interfere with the reproductive cycle in the human organism. The hypothesis of De Castro that a high protein intake reduces the rate of reproduction, as in the Scandinavian Countries in comparison with Formosa for instance, needs careful examination in this connection.

While calculating the reproductive index again, Professor Nair has divided the women of Travancore-Cochin on the basis of the decimal system into several age-grades. It is suggested that the age at which girls attain puberty, as well as the age at which menopause sets in be taken into consideration while classifying subjects into age-grade for purposes of reproductive life. For this varies from one group to another, and may also vary within the same group in course of time if habits of life change in a significant manner.

3. Mr. K. C. Basack (Calcutta)

Expressed the view that high birth-rate and rapid growth of population should not cause anxiety to Indian demographers. He pointed out that in its earlier stages industrialization in U.K. accounted for something like 15% population growth and further reduction of mortality. He said that even in India to-day there were some regions where there was dearth of population for cultivation. He felt that in view of the Development programme there was no need of reducing population in India.

4. Dr. V. G. Panse (Delhi)

In explaining a point raised by the previous speakers, referred to the limitations of sample survey and census data in supplying certain types of information. As for example, if one has to study whether fish-eating has any effect on the reproduction rate, this information can be had only from controlled experiments with fish-eating and non-fish-eating populations, thereby eliminating all other major factors likely to affect reproduction.

5. Besides the above speakers, Messrs M. V. Jambhunathan and Sundararajan also took part in the discussion.

6. The Chairman concluded the discussion by making out the following points: (1) Statistics was greatly needed in sociological studies 2) Anthropologists who conduct

study over small groups of people can throw much light on demographic problems and 3) the problem of population control is to be considered non-politically for Indian conditions.

Statistical Method in Genetics and plant Breeding

1. Mr. V. N. Amble (New Delhi)

Opened the discussion. He said that the applications of statistics to the study of inheritance of quantitative characters in animals and to the planning of animal breeding programmes have been, in India as elsewhere, fewer and much more recent than in plants. It is only in the last few years that at some of the State livestock farms work is in progress on systematic lines to progeny test the series and make selection on an objective basis. In the I.C.A.R., studies of available data at major livestock farms pertaining to breeding have been taken up with a view to making a quatitative evaluation of the policy of breeding that was followed and its consequences. Such studies help in giving guidance to the planning of future breeding programmes and in assessing the situation in respect of the genetics of the particular traits studied. They are at the same time of value in providing the most effective evidence to bring home to the breeders the need for planning and for a proper appraisal of the progress of work.

Problems in animal breeding are far more complex than in plant breeding for a number of reasons. Selfing, the closest form of inbreeding, which is so powerful a procedure in many plants such as wheat in quickly obtaining a so-called "pure-bred' strain, is out of question with animals. In animals we have to deal with the more complicated problems of biparental progenies. In large animals moreover the rate of reproduction is low and some of the characters of major economic importance such as milk production are sex-limited. All these add to the complexities of the problems.

Any programme of breeding involves two steps: (i) the selection of individuals to be used as parents and (ii) the choice of the mating system. Selection is the most important force in changing the frequency of a gene in a population and in thereby increasing the favourable genotypes. The mating system, while not affecting the gene frequency in the absence of selection, changes the proportions of different genotypes in the population and permits more, or less, effective scope for selection. Statistical considerations and methods play an important role in the correct choice in respect of both these components of a breeding plan and in evaluating the consequences of the adoption of any plan.

Selection can be effective in bringing about a change in the average value of a population in respect of a trait only when genetic variation for that trait exists in the unselected population. It becomes extremely important therefore to assess the genetic variation existent in a population.Secondly, selection in such a population will be effective in bringing about improvement to the extent it is made for genetic or real breeding value of the individuals. On the other hand, selection has necessarily to be based on phenotypic or observed values. The criterion or index for selection has to be therefore so chosen that it is correlated to a maximum extent with the genetic value of the individual.

A statistical comparison of the average performance of the progeny with that of their own dams may be seen to be a test of whether the sire used was genetically of a potentiality superior to the average of the dams used. An estimate of the breeding value of the sire or the sire index may also be calculated from the same data. The formulation of such an index, estimation of the standard error of the estimated index, possible corrections for herd to herd variations etc. and finally the combination of information from the pedigree records, records of sibs and other collateral relatives and from the progeny into an overall index, are all problems in which statistics is involved.

The data which furnish the progeny testing of the sires also enable us to obtain a rough estimate of heritability. The choice among alternative methods of estimation such as regression of daughters on dams and half-sib correlation, the possible corrections for environmental correlations and for the mating system, the manner of dealing with the records of more than one daughter per dam, and more than a single record per animal, such as several lactation records, are again problems for the application of statistical theory.

With the available information on the relative worth of sires and the approximate extent of genetic variation in the parent generation, the stage is set for the next phase of the breeding plan. What should be the rigour of selection among the males and among the females? What should be system of mating to be adopted? Which policy of selection—selection at what stage, and at each stage at what intensity, and based on what criterion—would be the most efficient and economic? The answer will obviously depend upon the genetic gains to be expected and the cost of maintenance corresponding to each policy. Solution to these problems can be attempted only with the aid of diverse tools of statistical science.

Finally, the most important question of all, viz., what should be the overall pattern of the breeding plan depends for its answer on the unravelling of some of the outstanding problems in statistics of genetics. These are to put briefly : detection and estimation of the magnitude of variation due to gene interactions or epistatic variations; detection and estimation of the extent of overdominance or superdominance as distinct from incomplete or complete dominance; and the estimation of the interaction between heredity and environment. If epistatic variation were important, some sort of line-breeding programme aimed at obtaining the optimum combination of homozygous phases of the factors involved might be best. On the other hand, if overdominance were present, some such programme as recurrent selection on the basis of combining ability with a tester cross or reciprocal recurrent selection may useful. If interaction between heredity and environment were high, it would be necessary to evolve distinct breeds for different ecological niches. We could expect to obtain answers to these questions in breeding only with further and intensive applications of statistical theory to animal genetics,

2. Dr. S. S. Prabhu (Izatnagar)

Dr. Panse in his presidential address had correctly pointed out that rapid headway made in the application of statistical methodology to genetics in foreign countries is to a large extent due to the existence of flourishing departments of genetics there. In India, on the other hand, we are still in the formative period; the need for separate chairs in Genetics at the Universities though felt, has not yeat taken shape. While this is the position in genetics, in statistics we have established schools of thought. There is no doubt that much can be achieved through a healthy co-operation between the statisticians on the one hand and the animal husbandry workers on the other. Statisticians would be particularly useful to the animal workers at the planning stage and later in interpretations of the results, while the animal husbandry workers could keep the statisticians abreast with the peculiar nature of the problems they had to tackle and assist them in evolving suitable tools.

Mr. Amble has covered most of the ground in animal husbandry where statistics could be profitably employed. He has also described some of the methods in detail. I would confine my remarks to the special problems that one encounters while trying to apply statistical methods developed largely from plant experimentation to problems in animal breeding. Unlike in plants the estimates of an economic character in animals have to be evaluated through recors spread over days, months and even years. Thus while yield of grains for example is obtained in one observation in plants, milk yield in animals for instance is spread over days, lactations and years of productive life of an animal. This makes the effect of environment a major factor in their cases. When we consider that the methods of management and animal husbandry practices also largely affect yields in animals, the problem becomes still more complicated. In India, with our variety of managerial practices, differing climatic conditions and breeds, it would be clear that environment is bound to exert an enormous influence on yield data of animals. It would therefore be necessary not only to find a suitable statistical yard-stick to correctly estimate the various economical traits which one would like to study, but also separately find their relative heritability under the special conditions met with here. The need for such studies was clearly recognised by the FAO conferece that met at Lucknow in 1950 to consider the problems of breeding livestock under tropical and sub-tropical conditions. Since cost of maintaining animals is an acute problem in any studies relating to animals a suggestion was thrown that possibly the facilities existing at the Key Villages started under the first Five Year plan might be profitably explored. An organised effort at this stage to see that the records kept at these centres fulfill the minimum statistical requirements, may in course of years produce valuable information that could be utilised in evolving suitable statistical tools and in answering many problems facing the animal husbandry workers in India to-day.

Finally, the lack of co-operation which is apparent but not real, between the statisticians and the animal breeders was ascribed to lack of understanding of each others' backgrounds and terminology. The language employed by the statisticians is at times obscure to the experimenter, while the details of the experiment itself and its finer aspects are not readily understood by the statisticians. An understanding of each others' "language" will pave the way for a healthy co-operation in the solution of the numerous problems that an animal husbandry worker has to face in India to day.

3. Mr. S. D. Bokil (Indor)

Apart from genetic variability, factors such as the number of gene pairs segregating, amount of environmental variability etc. are of importance to the progress by selection in which a plant breeder is interested. The effect of environmental variability on progress by selection is seen from the following figures of advance obtained theoretically by 10% selection in a selffertilized F plant population represented by genetic models consisting of 2, 8 & 32 equal factors without dominance producing unit genetic variance in F , for various ratios of genetic & environmental variabilities.

No. of factors	Ratio of genetic and environmental variabilities		
factors	1 : 4	3 : 4	5 : 4
2	0.779	1.138	1.298
8	0.783	1.147	1.306
32	0.784	1.148	1.308

Hence while judging materials for selection the plant breeder should estimate the amount of environmental as well as genetic components of observed variation.

It will also be noted from the results that the number of factors seems to have a very small effect on the immediate progress by selection. However it is known to be important form the point of view of continued selection. This number can be conveniently estimated by method given by Dr. Panse (Jour. Genetics, 1940).

4. Mr. J. S. Pruthi (Mysore)

In any field of science, in general, and biological sciences in particular, an able statistician undoubtedly plays a key or pivotal role and has three important contributions to make, viz. (i) to advise on the general statistical principles underlying the particular assay, (ii) to plan experimental designs which are likely to give most useful and reliable results, (iii) to analyse data so as to make the best use of the entire data collected. Before undertaking any designing or planning of any experiment, it is incumbent on the part of the statistician to have a fairly thorough grasp of the technical subject in hand and the practical difficulties of the field worker. The proper function of a statistician in scientific research and technology is, therefore, no longer merely that of analysing and summarising large bodies of experimental data; he is required to advice on the plan and conomy of each investigation, in the light of its operational efficiency.

Further, it is usually remarked that the plant breeders confine their studies only to physical aspects like yield of crops, size and shape of individual fruit etc. If at the conclusion of these Agri-cum-horticultural experiments, the fruits and vegetables are passed on to the next door chemist, physiologist and technologist, they will be able to report on the suitability or otherwise of the particular variety of fruit or vegetable from their view-point, and this should be of direct practical interest to the breeder or the grower. It is hardly necessary to emphasize that the services of a statistician will again be needed in each of these fields and then the variety of fruit which turns out to be an all rounder, i.e., which is nutritious, and delicious, can stand transport, storage and processing, will certainly fetch a reasonable premium over other varieties which lack these characters. In a nutshell, a close collaboration between a plant-breeder, a statistician, a nutritionist and a technologist with a thorough understanding of each others' difficulties and view-point, will definitely result in the production of maximum of useful and reliable results in the minimum possible time.

5. Dr. S. Bhaduri (Calcutta)

In experiments with clover and lucerne grown in test tubes and inoculated with suitable strain of *Rhizebium*, the numbers of nodules produced and dry weights of tops and roots determine the nature of the effect of symbiosis between the bacteria and the legume host plant. The heterogeneity of the data was partially controlled in the experiment by controlling the concentration of bacteria in the inoculum, volume of the media and rates of sowing; but the result may still be vitiated by the practical difficulty in limiting the genetical variability of the plant. Further, heterogeneity results from the interaction of this plant factor with treatment effects when replicated factorial designs are made.

Distribution of a large amount of data of uniformity trials on numbers of nodules and dry weights of plants showed that the population is markedly skew in nature.

Two varieties of clover plants '*g*' and '*x*' were sown singly or each in association with another plant of the same variety or a different one in test tubes and were inoculated with three bacterial strains A121111, 211 and f12. The plant variety '*g*' was known to give an effective symbiosis with A121111 and 211 and the variety '*x*' which differed essentially from '*g*' only on being homozygous for a recessive gene, gave an effective symbiosis with A121111 and ineffective symbiosis with 211. Both varieties, however, gave an ineffective symbiosis with f12. The experiment was designed factorially with two varieties of plants in three combinations of spacing and grown in presence of each of the three strains of bacteria in 8 replicates randomised in blocks. Analysis of variance showed that standard errors of nodule numbers and of dry weights were 36.01 and 33.88 per cent respectively of the general means. Treatment variances were tested for homogeneity by Bartlett's method to show that there were real differences between treatment variances and as such the comparison of means with pooled estimate of error is incorrect.

Non-normality of the data was evident and logarithmic transformation was resorted to for efficient comparison of the treatment effects.

6. DR. S. M. SIKKA (New Delhi)

also took part in the discussion.

7. DR. T. S. RAGHAVAN and DR. S. GOVINDASWAMY (Coimbatore)

The inter-relationship between genetics and plant breeding has been emphasised. From the realm of art plant breeding has passed on to the realm of an exact science with the re-discovery of laws of Mendelian heredity at the turn of the century. In the earlier investigations into the field of heredity, data were gathered by methods considered purely genetical. With the discovery of the presence of the genes, the hereditary units, genetics has come to assume a new complexion. Correlation of data obtained by genetical procedure with observations made by cytological technique, has become the rule in present day practice. This dual approach—"cyto-genetics"—involves a sound knowledge of statistical methods.

Obviously the methods followed in sugarcane breeding are of necessity a consequence of its cyto-genetical features. The fundamental fact to remember about sugarcane in this connexion is that as a breeding material, it is different from the other crop plants. This, of course, is due to its genetical constitution which in its turn is dependent upon its evolution. It is a highly heterozygous polyploid complex with a large reserve of lethal genes which especially in the officinarums are responsible for there being practically no selfed progeny. It is the clonal propagation that has made it survive the competition. The presence of diploid parthenogenesis in most of the pollen sterile forms adds to the complexity. There is therefore very little that could be done for purifying sugarcane. Thus inbreeding and pureline selection are of no avail in sugarcane breeding. The vagaries exhibited by sugarcane as a breeding material and their cytological basis have been described. Phenomena such as elimination of chromosomes *en bloc*, semblance of dosage effect of genes in some crosses and its absence in others, irregular phenotypic expression not easily explicable by established cytological causes, the presence of some sort of cytoplasmic inheritance in some crosses, non-segregation of parental characters due to autosyndetic pairing of the chromosomes—these have been indicated. For genetical studies sugarcane is not a favourable material.

The data that have been gathered have been subjected to statistical analysis and they have been presented. For instance in some crosses, the reciprocal differences with reference to particular characters, have been found to be statistically significant indicating the presence of an inheritance which is based upon an inter-action of the genes with the maternal cytoplasm. This has been found to apply even in cases where economic characters like yield and sucrose have been taken into consideration.

Some of the characters like tiller number, height, leaf length and width, appear *prima facie* polymeric in their inheritance. But subjecting the collected data to statistical analysis, it was found that they did not conform to the expectation.

Similarly when single qualitative characters are taken for genetical analysis, it was found that they did not conform to their monogenic or digenic inheritance. This is according to expectation, remembering that sugarcane is genetically a highly impure material, and the chances of establishing homo-zygosity are practically nil, owing to inherent cyto-genetical complications.

8. The Chairman wound up the discussion by calling attention to some of the points raised by the previous speakers. He explained the usefulness of statistical applications in plant and animal breeding from the point of view of optimum utilization of resources. He further observed that for fruitful application of statistical methods statisticians should know the problems and difficulties of the breeders while the breeder also must be familiar with the statistical approach and that mutual understanding between the two groups of workers was essential for rapid progress in the task of improvin our domestic plants and animals.

SECTION OF PHYSICS

Chairman : Dr. R. K. Asundi (Banaras)

VIII. Molecular Spectra and Molecular Structure

1. Dr. S. S. Dharmatti (Bombay) : *Nuclear Magnetic Resonance and Molecular Structure*

During the last five years the technique of nuclear magnetic resonance has considerably improved and has thereby made it possible to attain a very high degree of sensitivity and resolution. The development of very high precision nuclear induction spectrometer has now a resolution better than 1 part in 10^7 and with the use of such a high resolution spectrometer, nuclear magnetic moment measurements have proved in recent years to be effective means for studying numerous molecular and chemical problems. Nuclear magnetic moments and related measurements when suitably applied give useful information regarding the locations of atoms and electron density distribution in molecules, the nature of molecular bonds, chemical exchange, crystal structure and other variety of important chemical and structural problems. These and other allied problems arising out of the recent studies of nuclear magnetic resonances by various workers in this field will be reviewed and discussed.

2. Dr. M. L. N. Sastri (New Delhi) : *The Luminescence of Organic Molecules*

The luminescence of organic molecules in relation to molecular structure is briefly reviewed. Fluorescence spectra of aromatic hydrocarbons, and the effect of substitutions in the ring systems are discussed. The spectra of mono-,di-, and tri-substituted benzenes are compared. It is found experimentally that 1, 3, 5—trifluorobenzene vapour irradiated by light from Fe, Mn, Ni, Cd, Cu, Bi and Al sparks as well as from a mercury arc did not give any fluorescene spectrum. The probable causes for the quenching of fluorescence in this molecule as well as in chlorobenzene are discussed. The structures of these two molecules are compared with other mono- and symmetric tri-substituted benzenes which are known to yield fluorescence.

3. Dr. D. D. Pant (Nainital) : *Fluorescence spectra of uranyl Salts*

The spectra of Uranyl salts at ordinary temperature consist of broad and diffuse bands spaced at regular interval of about 860 cm^{-1} in fluorescence and of about 700 cm^{-1} in absorption. The fluorescene is observed in uranium salts containing the uranyl group (UO_2) and the spectrum is independent of the frequency of exciting radiation. At low temperatures a large number of line-like bands is observed. The resonance band which is common to both fluorescence and absorption spectra has in several salts a violet component with a frequency separation of about 150 cm^{-1}. These two bands show an interesting change in their relative intensity in fluorescene and absorption. The duration of fluorescence is of the order of magnitude of 10^{-4} sec. and no photo conductivity is observed. The fluorescence spectra also do not show Zeeman effect. The uranyl ion (UO_2) is paramagnetic and in uranyl sulphate the ion is reported to show paramagnetism increasing with temperature. The Raman and infra-red investigations have shown that UO_2 has three vibrational frequencies at 860, 930 and 210 representing symmetric, anti-symmetric and deformational vibrations. The molecule has a bent structure according to these data, although X-ray investigations are in favour of a linear molecular structure.

The fluorescence spectra are due to transitions from a single vibrationless excited electronic state to the various lower levels and all the three vibrational frequencies appear to take part. There is evidence for the ion having two close electronic levels forming the ground state. Analysis on this basis has also been attempted. The question of completely satisfactory analysis, origin of fluorescence and sharp bands, dependence of intensity of fluorescence on water of crystallization in the salt and several other problems are yet unsolved.

4. DR. D. SHARMA (Allahabad): *Recent advances in Diatomic Molecular spectra*

In addition to the more accurate determination of molecular constants of diatomic molecules by using better resolutions, altogether new techniques have recently been applied to the study of molecular spectra. The use of microwaves and magnetic and electric resonance spectra have not only enabled the determination of those molecular constants which could not be found by the ordinary spectroscopic methods, but have also supplied useful information about nuclei.

To explain the spectra of planets and stars where the conditions are considerably different from those existing in the laboratory, various devices of excitation have been developed. In the investigation of the forbidden transitions in absorption use of multiple reflexion arrangement to increase effective path lengths has been of immense use. Forbidden band systems have also been excited in uncondensed discharges run in the presence of a rare gas like A or He at reduced pressure.

The study of the absorption spectra of radicals, along with the investigations of the spectra of flames, has contributed a good deal towards understanding the mechanism of combustion.

Recently a number of band systems involving transitions between terms of high multiplicity have been observed and studied.

5. DR. M. R. PADHYE (Bombay): *The lowest triplet states of some Aromatic Hydrocarbons*

Recent theoretical work on the energy levels of aromatic hydrocarbons in the polyacene series has focused attention particularly on the experimental assignments of transitions in this series. In the case of anthracene, the lowest triplet level was reported at

14,700cm^{-1} (Lewis and Kasha, 1944). Recently, C. Reid in three papers has offered three different lines of indirect evidence against the earlier assignment.

We have re-examined the anthracene lowest triplet level by two independent direct approaches :

(a) the phosphorescence spectra at 77°K of anthracene and seven variously halogented anthracenes.

(b) the single-triplet absorption of 9,10-dichloro and 9,10-dibromo-anthracene using long optical paths.

These experiments have led to the certain confirmation of the earlier assignment of 14,700 cm^{-1} as the height above the ground state of the lowest triplet level of unsubstituted anthracene. The results are unambiguously confirmed by the perturbation experiments reported by McGlynn and Kasha.

The work was done in the Department of Chemistry, Florida University in collaboration with S. P. McGlynn and M. Kasha under a contract between the office of Naval Research and the Florida State University.

6. Dr. V. Ramakrishna Rao (Waltair) : *Spectra of Rotational Isomers*

Investigations in the Raman and Infrared spectra established the existence of two or more isomeric forms in molecules like substituted ethanes, Oxalyl chloride etc. Observation of more Raman lines particularly of the polarised type, than can be expected for one form alone, led to this suggestion. Also the coincidences between the Raman lines and the Infrared bands at room temperature were larger than expected. In the low temperature Raman spectra only a few lines persisted with undiminished intensity. These lines were attributed to the TRANS form (C_{2h}). At ordinary temperatures, either the CIS(C_{2v}) or the GAUCHE(C_2) forms co-exist with the stabler TRANS form, giving rise to their own spectra. A systematic increase in the intensity of the lines corresponding to the CIS or GAUCHE forms at the expense of those due to the TRANS form indicates that with higher temperatures more molecules change over into the CIS or GAUCHE forms. From measurements of intensities at various temperatures the potential barrier separating the two forms was estimated to be $\underline{\frown}$ 3KCal/mol. This small value is responsible for the ready transformation at ordinary temperatures thus making the chemical separations of the isomers impossible. No satisfactory evidence is yet found for the rotational isomers from the U.V. absorption spectra.

IX. Nuclear Structure

Chairman : Dr. R. K. Asundi (Banaras)

1. Dr. B. Peters (Bombay) : *Unstable Particles in high energy Nuclear Physics*

The paper will summarize the existing information on various unstable particles and discuss the known properties of both heavy mesons and hyperons. It will also deal with the experimental techniques which have been developed in recent years for the study of these rare and short-lived forms of matter.

2. Dr. S. Biswas (Bombay): *Observations on Heavy Unstable Particles*

Heavy unstable particles observed in emulsion blocks composed of stripped emulsions, exposed in the stratosphere have been analysed. The production, mass estimation, decay scheme and the interaction of these particles are discussed.

3. Dr. S. Jha amd Mr. R. K. Gupta: *The Excited States of RaE*

A proportional Counter Spectrometer with a single channel analyser, has been set-up. Electromagnetic radiations from RaD have been studied. Peaks were observed at 47 Kev, 16 Kev, 13 Kev, 11 Kev, 8 Kev and extremely weak ones at 23 Kev and 36 Kev. 47 Kev and the Bi LX-rays are well known. 8 Kev peak is shown to be due to the material (brass) of the counter. The peak at 23 Kev is due to the build up. The significance of 36 Kev peak in the light of recent calculations and experimental results is discussed.

4. Dr. E. Kondaiah: *Excited Levels in C^{12}*

Separated B″ target (100 Kev thick for 1 Mev deutrons) is bombarded with 1050 Kev deutrons obtained from the Canberra Cockroft-Walton accelerator. Nuclear emulsion plates (200μ thick) have been exposed to the outcoming neutrons at different angles with respect to the deutron beam. The plates have been processed using the temperature development technique. Recoil proton tracks falling within 10° to the incident neutron direction have been measured, and the neutron spectrum has been obtained. The neutron spectrum thus obtained shows some new levels in C^{12} in addition to the levels hitherto reported.

5. Dr. A. Mukerji (Bombay): *Low-lying Energy Levels in the Region N or $Z=20$ to 38.*

The low excited states of the odd A nuclei in the region N or $Z=20$ to 38 bear out many of the salient features of the nuclear models. Of particular interest are the first excited states of some of the scandium isotopes and of Cu^{65}. Experimental results obtained with a scintillation γ-ray spectrometer are discussed.

6. Dr. K. S. Singwi and Dr. L. S. Kothari (Bombay): *Thermal Inelastic Scattering of Cold Neutrons in Polycrystalline Solids*

A general theory of the influence of thermal motion on the scattering of slow neutrons in polycrystals is discussed. Expressing the temperature displacements of the lattice points as a sum of emission and absorption operators, the matrix element for the transition of a neutron from an initial to a final state through the absorption of a single phonon is deduced. The theory is then generalized to take account of multi-phonon processes. Our method gives an alternative and a simple proof of the Debye-Waller factor.

General expressions for both the incoherent and coherent cross-sections, corresponding to a phonon process are derived. The latter, hitherto not treated rigorously, is examined in detail. It is shown that it can be expressed as a sum of two terms, of which the main term, apart from a constant, is identical to the expression for the incoherent part and the other is a correction term. Both terms are put in "Placzek" form and for cold neutrons explicit expressions are obtained for the cases : (i)$M \gg 1$ and $T/\theta \gg 1$, (ii) $M \sim 10$ and $T/\theta \geqslant 0.5$.

Numerical results for magnesium, aluminum, iron, lead and beryllium are discussed and compared with experiment. The agreement is found to be satisfactory.

7. Dr. B. V. Thosar and Mr. M .C. Joshi (Bombay) : *Gamma-ray Energies in the Decay of Cs^{134}*

Photo-electric conversion spectrum of gamma-rays in the decay of Cesium-134 of 2.3 years half-life, was studied with a Siegbahn-Slatis Beta-ray Spectrometer, using a strong source and thick lead and uranium as radiators to bring out weak lines. In addition to seven gamma-rays reported previously by most of the observers, two gamma-rays of energies 467 Kev. and 1401 Kev., have been recorded. The former of these is shown to arise from one of the level-schemes already proposed. The latter, which is a weak one, is energetically possible as a cross-over transition but this is not consistent with the spin-assignments made in previous work. The more recent work of J.M. Cork and others on this isotope is also discussed and coincidence spectrometric measurements, now in progress, are described.

8. Dr. K. G. Vohra : *The Measurement of Weak Radioactivities and an Investigation on the Radioactive Content of Air in Bombay*

The collection of radioactive ions and the detection of alpha activity with proportional counters, have been used for the study of weak radioactivities, and especially the radioactive content of the air. The ion-collector consists of a long cylinder, with a small negatively charged co-axial rod on which the collection is made. A streamlined flow of air is obtained through the collector. The proportional counters are filled with hydrogen and argon at pressure of 4 to 5 cm. hg. The high voltage supply used with the counters gives a stabilisation of 0.1% for normal fluctuations in the supply-mains. Bias plateau curves of the proportional counters have been studied. A high gain linear pulse amplifier with a discriminator, a scale of 8, and the necessary recording circuits have been used with the counter.

With this apparatus measurements have been made with the weak sources prepared in the laboratory, contamination of the air in laboratory rooms and the radioactive content of the free air.The measurements of the radioactive content of the free air were made in different months during 1952-53. The locations used were the top of the College building and the local observatory at Colaba.

For interpreting the results of the free air experiments, a theoretical analysis of the radioactive contamination of the air has been carried out. The results show that

(1) the air blowing from the land has a random concentration of the order of 100 atoms per litre, with little or no thoron. This is fully accounted for by the normal uranium content of the rocks and soils and it can be deduced with high probability that the land areas to the N and NE of Bombay contain no extensive uranium minerals near the surface; (2) when the winds are mostly from the S and SW, the air has thoron which is shown to be of recent origin. The thoron content of the winds from the sea comes from the local coastal sands and it is established that traces of thorium-bearing minerals are present in the sands along the coastline.

9. Dr. N. K. Saha (Delhi): *Fast Neutron-Reactions in Nuclei (Experimental)*

It is pointed out that the changing character of nuclear reactions with neutrons, as the energy of the neutrons is varied from a few eVolts to $\geqslant 50$ MeV, and light to medium heavy and heavy nuclei are chosen, can be generally understood as a consequence of variation of level-width of nuclei in different regions of nuclear excitation and the Gamow penetration factor of Coulomb barrier. Factors like the shell structure of nuclei, high angular momenta of the particles etc., may influence the results only in special cases. In this context the study of 'threshold reactions' in intermediate nuclei fast neutrons ($\leqslant 10$ MeV) appears to be particularly promising. In suitably chosen target nuclei these reactions can be produced at an average constant neutron energy well within the sum of the reaction threshold and the height of the potential barrier. Any observed variation of the reaction cross-sections with mass number under these circumstances would then reflect the level-width variation of the nuclei. Results of such experiments performed on the measurement of relative cross-sections of (n, p)-reactions in S^{32}, P^{31}, Mg^{24}, Al^{27} and Fe^{56} using a Cd-filtered 100 mgm $Ra\alpha + Be$)-source are reported. Determination of absolute cross-section of (n, p) -reaction in S^{32} using the same source and a 'poor' spherical geometry is described. This involves electrical and chemical separation of radiophosphorous P^{32} (14.3 days) produced from the S^{32}-reaction and the determination of the absolute β-ray counting efficiency of the G.M. counter. The relative cross-sections obtained for the different cases are then converted to absolute values. The results so far obtained are discussed and appear to be encouraging in the light of the meagre existing data in the field.

10. Dr. S. N. Ghoshal and Dr. A. N. Saxena (Calcutta); *On Beta Energetics and Nuclear Shell Structure*

The existence of discontinuities in neutron and proton binding energies have been observed at magic neutron and proton numbers by various workers. This effect should be reflected in the β-disintegration energies of radioactive nuclei, since it depends on neutron and proton binding energies. The discontinuities should become more marked if the difference $\varepsilon_\beta\ (A, Z)$ between the observed β-disintegration energies ${}^{e}_{\beta}\ (A, Z)$ and the corresponding values $E^{c}_{\beta}\ (A, Z)$ calculated from Fermi—Weiszacker formula is plotted against N or Z. Discontinuities in $\varepsilon_\beta\ (A, Z)$ have been observed at $N=50$, 82, 126 and $Z=50$, 82 by the present authors.

The discontinuities in the β-disintegration energies at shell crossings have been explained by Suess and Jensen, Coryell and others as being due to discontinuities in Z_A values involved in Fermi-Weiszäcker formula, as also in the pairing energy term

$(\pi-\nu)$. Coryell has estimated the discontinuities in these two terms at various shell crossings. In the present investigation, the presence of $(\pi-\nu)$ effect between even and odd Z nuclei (for odd A) have been demonstrated most remarkably by plotting the the observed β-disintegration energies of an isobaric sequence against Z for different values of A.

The average $(\pi-\nu)$ effect has been calculated by comparing the values of $\varepsilon_\beta\ (A, Z)$ for three or more consecutive Z values for a given A (odd). When the observed β-energies of an isobaric sequence, corrected for the $(\pi-\nu)$ effect, are plotted against Z, straight lines are obtained whose slopes give the B_A values involved in the $F-W$ mass formula. These B_A values deviate considerably from the B_A values calculated from the Fermi parameters. It seems that either the B_A values should be modified in order to account for the observed β-energies; alternatively, if the B_A values given by Fermi parameters are not changed, then $(\pi-\nu)$ values for each individual member of an isobaric sequence has to be specified.

Section of Chemistry

X. MODERN TRENDS IN ANALYTICAL CHEMISTRY.

Chairman : PROF. S. M. MEHTA (Bombay).

GROUP I (CLASSICAL METHODS)

1. PROF. S. M. MEHTA and (MRS.) G. G. KAPADIA (Bombay) : *Separation of Alkaline Earths from one another.*

During the course of investigations on the decomposition of alkaline earth sulphates, the question of the estimation of alkaline earths, when present in a mixture appeared to be of importance and to merit a special study. According to Hillebrand and Lundell 'No really good methods for separating calcium, strontium and barium are known. They are all imperfect and give correct results only through compensating errors.' A search of literature revealed that the methods described are either elaborate or have limitations in their applicability or are subject to appreciable errors. A method for the qualitative analysis of the barium group of metals based on the difference in the solubilities of the sulphites of calcium and strontium in dilute acetic acid was described by Hinds (*J. Amer. Chem. Soc.*, 1911, *37*, 510-14). He, however, did not make any further study nor did he conceive the idea that the sulphite method could be developed into an excellent quantitative method of separation. There appears to be no other reference bearing directly on this subject.

A method has been developed in which advantage is taken of the increased solubility difference of calcium sulphite from strontium sulphite or barium sulphite in an aqueous solution containing equal parts of sodium sulphite and bisulphite. Standard conditions have been established for the separation of alkaline earth sulphites from one another. The standardised method has been applied to mixtures containing chlorides or nitrates of alkaline earth metals and it is found that a quantitative separation of the three alkaline earths from one another is possible with an error less than one per cent.

A method has also been worked out in which calcium sulphate can be quantitatively separated from a mixture of alkaline earth sulphates by taking advantage of the fact that lead sulphate is relatively less soluble than calcium sulphate in the presence of potassium acetate. It is found that calcium sulphate may be dissolved and estimated with an error not exceeding half a per cent by choosing the proper molar ratio of calcium sulphate and lead nitrate.

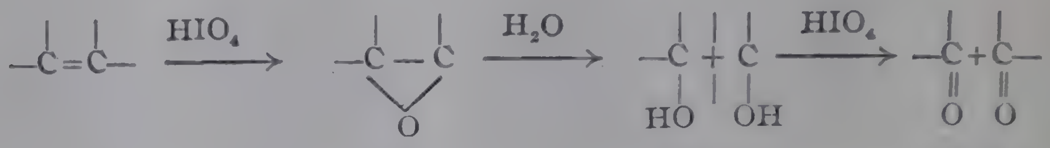
The sulphite method has been extended to the separation of calcium from magnesium and it is found that this separation is also quantitative (*cf.* Carron, *Ann. Chim. anal.*, 1912, *17*, 127-29).

2. DR. ASIMA CHATTERJEE and DR. SUDHENDU GHOSH MAJUMDER (Calcutta) : *Periodic Acid—An Analytical Reagent for Exocyclic and Terminal Double Bonds.*

Malaprade reaction of periodic acid is well-known. It is used as a selective oxidising agent for various organic compounds containing hydroxyl groups or hydroxylamino groups attached to adjacent carbon atoms.

A new reaction of periodic acid has been studied by the present authors. It has been observed that periodic acid can be used as an analytical reagent for exocyclic and terminal olefinic groups in water-soluble organic compounds, carbon-carbon double bond undergoing facile cleavage (at 100°) and giving rise to carbonyl compounds. These carbonyl products can be readily characterised by their dimithones or 2 : 4-dinitrophenylhydrazones. For establishing the general applicability of the reagent, periodic acid oxidation has been studied with compounds of known structure such as glycosine (Chatterjee and Ghosh Majumdar, *J. Amer. Chem. Soc.*, 1954, *76*, 2459), quinine, quinidine, cinchonidine, cinnamic acid and corynantheine etc. It has been possible to establish that like ozone periodic acid can be used for detecting the presence and the exact site of unsaturation (either exocyclic or terminal olefinic groups) in organic molecules.

Plausible reaction mechanism of periodic acid is suggested as schematically drawn below :



(I) (II) (III) (IV)

The reaction proceeds excellently with water-soluble compounds. With water-insoluble substances several difficulties were encountered but these could be overcome by using suitable polar and nonpolar solvents. During the reaction iodine is found to be liberated which shows that periodic acid is reduced to iodine during the oxidation of double bonds.

3. DR. G. GOPALA RAO (Waltair) (In Absentia) : *Sodium Vanadate as a new Oxidimetric Reagent.*

Numerous oxidants have been introduced from time to time as titrimetric reagents in Volumetric analysis, such as potassium permanganate, potassium dichromate, ceric sulphate and other ceric salts, potassium iodate, potassium periodate, potassium bromate, chloramine-T, etc. During recent years, Gopala Rao and coworkers have shown that sodium vanadate has special advantages over potassium permanganate, potassium dichromate and ceric sulphate as a volumetric reagent. It can be used for the estimation of ferrous salts in the presence of oxalic acid, citric acid, tartaric acid, alcohols and phenols, where potassium permanganate, potassium dichromate and even ceric sulphate give too high results. They have also employed sodium vanadate for the volumetric estimation of ferrocyanide alone and in the presence of hydrochloric acid, and oxalic acid; hydroquinone, in the presence of some phenolic compounds; and of uranous salts using diphenyl benzidine and other redox indicators. Sodium vanadate has also been used for the estimation of tartaric acid, and other organic compounds.

It is proposed to discuss in this paper recent developments in this field.

4. DR. G. GOPALA RAO (Waltair) (In Absentia) : *Cacotheline as a Reagent for the Detection of Ferric Iron.*

Cacotheline is a nitro derivative of brucine. This has been used extensively for the spot test detection of stannous tin. It is proposed to discuss in this paper, the recent work of Gopala Rao and coworkers on the use of Cacotheline as a reagent for the detection of ferric iron.

5. DR. I. K. TAIMNI (Allahabad) (In Absentia) : *Analysis of Metals by formation of Thiosalts and Precipitation of the Sulphides.*

Investigations carried out in this laboratory on the formation of thiosalts and the precipitation of sulphides by acidifying such solutions have yielded very interesting and useful results. These results have found application both in qualitative and quantitative analysis.

In the field of qualitative analysis, it has been shown that the formation of thiosalts can be utilized for the rapid and complete precipitation of metals like molybdenum, platinum and arsenic (arsenate) whose precipitation by hydrogen sulphide in acid solution is very tedious and takes considerable time. This discovery has been utilized in modifying the scheme of qualitative analysis for the basic radicals, the use of hydrogen sulphide being replaced by 1 N sodium sulphide reagent which easily forms thiosalts with the metals of the arsenic group.

The precipitation of sulphides by the decomposition of the corresponding thiosalts has also found wide application in gravimetric analysis. Many metals which are generally precipitated by hydrogen sulphide in acid solution for their gravimetric estimation, can be precipitated in a much shorter time by first forming and then decomposing the corresponding thiosalts. The precipitates of sulphides obtained in this manner, are easily filterable and can be weighed directly after washing with either ether and alcohol or water alone. The method has been shown to be applicable to arsenic, selenium, tellurium, molybdenum, tin, antimony, gold and platinum metals with the exception of osmium. Many metals which do not form thiosalts can also be precipitated and estimated as sulphides more satisfactorily by first precipitating them in alkaline solution and then acidifying the mixture before filtration.

The results of these investigations have been published in a series of papers in Analytical Chimica Acta in 1953-1954.

6. DR. BALWANT SINGH (Hoshiarpur) (In Abstentia) : *Volumetric Studies in Oxidation—Reduction Reactions : Oxidation with Potassium Meta-periodate. Iodine Monochloride Method.*

Potassium metaperiodate in acid solution is a strong oxidising agent and is reduced to iodine;

$$2\ IO_4^- + 16\ H^+ + 14\ e = I_2 + 8\ H_2O$$

The iodine is further oxidised by the periodate

$$3\ I_2 + IO_4^- + 8\ H^+ = 7\ I^+ + 4\ H_2O.$$

The end of the titration is reached through this reaction whose completion is shown by the disappearance of the free iodine. Iodine cation forms a stable iodine monochloride, iodine cyanide and iodine bromide complex in the presence of a high concentration of hydrochloric acid, of hydrocyanic acid and of bromide ions respectively. Potassium Metaperiodate has been used as an oxidising agent in acid medium for the volumetric estimations of a large number of substances by the Iodine Monochloride, the Iodine Cyanide and the Iodine Bromide method.

The Iodine Monochloride method has also been developed in volumetric estimations, using Sodium Metavanadate, Chloramine—B and Chloramine—T as oxidising agents.

7. DR. R. C. MEHROTRA (Allahabad) (In Absentia) : *Application of Adsorption Indicators in Chemical Analysis.*

Since the discovery by Fajans in 1923, adsorption indicators have been extensively employed in chemical analysis. During the last ten years, a number of new adsorption indicators have been described by the author to be very useful in a number of titrations under special circumstances. For example, resorcinol quinolein (Proc. Nat. Acad. Sci., 1946, *15*, 148) can be used in the titration of halides in acidic solution whereas bromophenol blue (Anal. Chim. Acta, 1949, *3*, 78) can be used for the above titrations both in acidic as well as ammoniacal solutions. Similarly tetra-iodo phenol sulphonphthalein has been found (Zeit. Anal. Chem., 1950, *130*, 390) to be a very useful indicator for the titration of mercurous ions.

In addition to the above, the author has described the applicability of a new class of adsorption indicators which have got both acidic as well as basic groups in their molecules and hence can be used in the titration of cations against anions as well as in the reverse titrations. Examples of indicators of this class are congo red (Anal. Chim. Acta, 1948, 2, 36) and phenyl-α-naphthylamine azobenzene p-sulphonic acid (J. Ind. Chem. Soc., 1949, *26*, 511).

Moreover, the applicability of adsorption indicators has been extended to the estimation of thallium for the first time and it has been shown (Anal. Chim. Acta, 1949, *3*, 73 and 78) that with the help of tetrabromophenol sulphonphthalein as adsorption indicator, thallous ions can be estimated either alone or in a mixture of silver and thallous ions.

Besides the practical applicability of the above indicators, the work has thrown fresh light on the mechanism of their colour change. Contrary to the conclusions of earlier workers, it has been shown that the adsorption indicators are held to the surface of the precipitates by forces of chemisorption and hence, the chemical structure of a particular indicator determines the conditions under which it can be employed.

8. SRI S. K. BOSE, SRI U. K. BENEGAL and DR. A. N. GHOSH (Calcutta) (In Absentia) : *Comprehensive Method of Analysis of Paint Pigment—Part I—Rapid Method of Analysis of Zinc in Composite Paint Pigment.*

All standard methods of estimating zinc by ferrocyanide titration with an internal indicator stipulates isolation of zinc from interfering elements as sulphide. This involves the conventional group separation by sulphuretted hydrogen and in the case of pigments,—a class of material in which compounds of lead, lime, iron etc. very commonly occur with zinc oxide the volumetric titration does not offer any conspicuous advantage over the gravimetric method of estimating zinc.

Procedure has, however, been evolved which offers a very rapid means for estimating zinc oxide in pigments by the ferrocyanide titration. Zinc oxide of pigment is extracted with an ammoniacal solution of some ammonium salts effecting its simultaneous separation from extender as well as compounds of lead, lime, iron etc. The solution, after acidification with sulphuric acid, is boiled with either sulphurous acid or bromine water to adjust its oxidation—reduction potential which might be rendered high, or low with respect to diphenyl amine, due to contamination with chromate or any organic matter of pigment. It is then directly titrated with potassium ferrocyanide by the internal indicator method.

Estimations on a number of pigments of divergent nature show that the evolved procedure when compared with the orthodox volumetric or gravimetric methods, has the advantage of rapidity while making no compromise in respect of accuracy. It has also been found to serve as a quick and convenient means to estimate total and free zinc oxide in a mixture of zinc oxide and lithopone (coprecipitated barium sulphate and zinc sulphide), the total zinc being determined on an ignited sample.

GROUP II (INSTRUMENTAL)

9. DR. SANTI R. PALIT and SRI G. R. SOMAYAJULU (Calcutta) (In Absentia) : *Nonaqueous Titration: A New Development in Analytical Chemistry.*

The subject of *'nonaqueous titration'*, *i.e.*, titration conducted in water-free solvents, has gathered tremendous momentum in recent years. In contradistinction to the well-understood classical method of *'aqueous titration'* for the estimation of strong and moderately strong acids and bases, the method of nonaqueous titration admits analysis of weak acids and bases. The need for alternative media arises also from the fact that water is not an appropriate solvent for many compounds and, thanks to the brilliant conception of Lowry-Brönsted and Lewis, the behaviour of the latter in nonaqueous media has been made comprehensive, which has greatly contributed to our choice of proper solvents.

It follows as a direct consequence of the modern theory of acids and bases that *a weak base would appear stronger in an acidic solvent and similarly a weak acid would appear stronger in a basic solvent.* Taking this hint, Conant and Hall, the pioneer workers in this line, showed that weak bases could be titrated in acetic acid. Palit demonstrated the advantage in using glycol, a Lewis acid, in conjunction with a suitable cosolvent. These titrations are now being referred to as *'acetous'* and *'glycolic'* titrations. Moss, Elliott and Hall, on the other hand, conducted the most suggestive titrations of weak acids, *e.g.*, phenols, in ethylenediamine, a basic solvent, analogous to the titration of weak bases in acidic solvents. Higuchi *et al.* studied the possibility of effecting titrations of such weak acids as alcohols, hydrocarbons, etc.

Thus a fresh and a promising field of research has been opened which has already scored striking triumphs in the realm of analytical chemistry.

10. Sri R. S. PHADKE, Sri R. S. SUBRAHMANYA and Dr. M. R. A. RAO (Bangalore) : *Polarography in Non-aqueous Media : The Diffusion Currents of Nitrophenols in Ethanol-water Mixtures.*

The variation of the diffusion current of ortho-, meta- and para-nitrophenols, has been studied in aqueous solutions containing various proportions of ethanol, at four pH values. It is observed that the diffusion currents of the nitrophenols decrease as the % of the ethanol in the solution is increased. The diffusion currents are, however, proportional to the concentration of the nitrophenol in all the solutions studied. The nature of the wave is dependent on the % of ethanol in the solution at a given pH. The number of reduction steps given by a compound is not affected by the % of ethanol in the solution. The number of electrons involved in the reduction steps at different *p*H values has been discussed.

From the analytical point of view, absolute ethanol was the best solvent. A solution of ortho-Nitrophenol (0·5—4·0 millimoles per litre) could be estimated polarographically correct to ±2%.

11. Sri S. K. DHAR (Poona) (In Absentia) : *Reduction of Tetravalent Germanium at the Dropping Mercury Electrode.*

The polarographic reduction of Ge^{+4} in the form of GeO_2 dissolved in distilled water has been studied in buffered and unbuffered media. Well-defined irreversible reduction waves were observed in both boric acid and bicarbonate buffers. In 0·25M boric acid adjusted to pH 7·8 with KOH, the $E_{1/2}$ at 30°C is—1·485 V (S.C.E.) and in 0·25M $KHCO_3$ adjusted to pH 7·4 with HCl the $E_{1/2}$ is 1·435 (S.C.E.). The $E_{1/2}$ shifts to less negative values by addition of electrolytes such as KCl or $NaClO_4$. This effect is pronounced in boric acid at a lower pH range around 6·5. The shift is accompanied by increase in the wave height. The change of $E_{1/2}$ *Vs* pH in the pH range 6·5—9·0 is small. Experiments in boric acid media at higher pH values show a gradual shift of $E_{1/2}$ to more negative values and decrease in wave height, the effects being marked at pH values beyond 10·5. The Id/C values observed in 0·25M boric acid at pH 7·8 and 0·25M $KHCO_3$ at pH 7·4 are fairly constant up to $10^{-4} \times 8M/1$ without addition of gelatine or any other surface-active agent.

The reduction scheme may be represented by : $HGeO_3 + 4e + 2H_2O \rightleftharpoons Ge^{\circ} + 5OH^-$, but it is assumed that the reducible species is a polygermanic acid, probably

$H_2Ge_5O_{11}$ which undergoes depolymerisation at higher pH values giving products which have more negative reduction potentials than that of the supporting electrolyte. Polargrams in KCl media, in absence of a buffer show a smaller limiting current and a more negative E½. This observation is explained on the basis of the above-mentioned reduction mechanism, since the reduction in an unbuffered medium will lead to an increase of pH at the D.M.E.-solution interface, and the germanic acid diffusing into this region will behave similarly as in a medium of a high pH.

The standard potential data and the comparison of d.c.c. of Ge^{+4} in our study with that of Ge^{+2} as reported in literature, indicate 4e reduction. Further information might be obtainable from a detailed examination of the nature of the wave. The investigation is being continued to elucidate the above reported effects of electrolytes, the general nature of the wave, etc., whereby a clearer picture of the reduction process is hoped to be drawn.

12. SRI P. R. SUBBARAMAN (Poona): *Electro-deposition of Complexed Germanium from Aqueous Solutions.*

Electrodeposition of germanium in thick layers from aqueous baths has not been successful, owing to the low over-voltage of hydrogen on germanium. Germanium can, however, be co-deposited with certain other metals, particularly with those which alloy with germanium easily. The deposition of the metal from its oxalate complex has been studied in view of the fact that such solutions are often obtained in the extraction of germanium from low-grade sources. It has been found that milligramme quantities of germanium, present as the oxalate, can be quantitatively co-deposited with copper on a platinum or copper cathode from a cyanide solution containing at least four times as much copper as there is germanium present. Co-deposition with copper is also possible from ammoniacal as well as from alkaline tartrate baths under controlled conditions. There is also evidence to indicate that co-deposition of germanium with silver can be effected from a cyanide solution.

Co-deposition of germanium with tin from an alkaline oxalate bath showed that the germanium deposit was limited to thin flashes of the metal.

13. DR. BH. S. V. RAGHAVA RAO (Waltair): *Polarography of the Rare-Earths.*

Noddack and Brukhl indicated from their studies that the rare-earths undergo a stepwise reduction $M^{+++} \rightarrow M^{++} \rightarrow M^0$ at the dropping mercury electrode. These could not be confirmed by later workers; *e.g.*, Leach and Terrey with Scandium, Glockler *et al* in the case of Neodymium, Praseodymium and Gadolinum. Evidence is now adduced to show stepwise reduction in La, Pr, Nd, Sm (the last previously admitted) Gd, Dy and Yt. Sc stands apart confirming the findings of Leach and Terrey. The half wave potentials of the elements for the first wave are between—1·79 and 1·90 v vs S.C.E. and for the second between—1·94 to 2·94 to 2·03 v similarly. The limiting currents in the first wave show linearity with concentration, while in the second wave La, Nd and Pr yield linear relations. Other elements exhibit an anomalous behaviour. An attempt is made to explain this behaviour from disturbing electrode reactions. In all cases the hydrogen wave has been separated and the influence of pH on E½ values and limiting currents is also presented.

14. DR BH. S. V. RAGHAVA RAO (Waltair): *Spectro Photometric Study of Metal Lattes and Chelate Complexes.*

From a study of the extinctions of metal oxinates, alizarin-sulphonates and other dyes, like haematin and haematoxyl, the possibility of their estimation is indicated.

Possible structures for the metal complexes are discussed, in particular the 4-5 oxinates of thorium and 2-3 oxinates of uranium in different solvents.

15. DR. G. V. L. N. MURTY (Jamshedpur) (In Absentia) : *Modern Trends in Steel Works Analysis with special reference to Spectrographic and Absorptiometric Methods.*

16. DR. BALWANT SINGH (Hoshiarpur) (In Absentia) : *Potentiometric Studies in Oxidation—Reduction Reactions : Oxidation with Chloramine-B.*

Chloramine-B has been used as an oxidising agent to determine indirectly potassium iodate, potassium metaperiodate, potassium bromate, potassium dichromate, hydrogen peroxide, chloramine-T and potassium permanganate by a potentiometric method. An excess of potassium iodide added to each of the substances in an acid medium was titrated back with a standard solution of chloramine-B, using platinum foil as an oxidation-reduction electrode coupled with a saturated calomel electrode through an agar-agar potassium chloride bridge.

It has been used as an oxidising agent for the potentiometric determination of potassium ferrocyanide, hydroquinone, hydrazine sulphate, potassium antimonyl tartrate, ferrous sulphate, quinhydrone, potassium iodide and arsenious oxide. In acid medium each substance was directly titrated potentiometrically with a standard solution of chloramine-B.

An attempt has been made for the potentiometric estimation of some aldehydes using chloramine-B as an oxidising agent.

17. SRI C. S. RAMANATHAN and SRI R. S. SUBRAHMANYA (Bangalore) (In Absentia) : *Effect of Solvent on the Diffusion Current of Ortho-iodobenzoic acid.*

The diffusion currents of ortho-iodobenzoic acid in different aqueous mixtures of ethanol, acetone, and dioxane have been determined, using lithium chloride as the supporting electrolyte. These determinations were made in solutions of different pH values. In all the solutions studied, it was noticed that the diffusion current decreased as the concentration of the organic solvent in the base electrolyte is increased. The wave forms were also affected by the solvent concentration. Good proportionality between the diffusion current and the concentration of the reducible substance was observed. The diffusion coefficients of ortho-iodobenzoic acid have been determined under polarographic conditions in all the solutions in which the diffusion currents were measured. For analytical purposes, a base electrolyte containing 50% dioxane (especially in the alkaline region) may be used with which an accuracy of $\pm 1{\cdot}3\%$ could be obtained.

18. SRI B. R. LAKSHMANA ROW and SRI C. C. PATEL (Bangalore) (In Absentia) : *Spectrophotometric Estimation of Thorium in Travancore Monazite.*

Further work on the estimation of thorium by the morellin method has indicated that the thorium content of the Travancore monazite can be estimated after removing the interfering radicals. The monazite is digested with concentrated sulphuric acid and the insoluble silica is filtered off. The slightly acidic filtrate is treated with oxalic acid to remove thorium and rare earths as oxalate precipitates. The oxalates thus obtained are ignited and the oxides are converted into nitrates. The solution of the nitrates in water is diluted with 60% alcohol. On mixing the alcoholic solution of morellin with the nitrate solution, an orange yellow complex, in the pH range 5 to 7, is obtained. The transmittance measurements on the complex are carried out at $\lambda = 515\mu$, employing Coleman Model 14 Universal Spectrophotometer. The thorium content in the solution could be computed from a standard calibration curve for thorium-morellin complex. 0·4 to 50 p.p.m. of thorium in the solution can be estimated with an error of 3 to 5%.

19. SRI A. R. VASUDEVA MURTHY (Bangalore) (In Absentia): *A Simple Thermogravimetric Balance.*

Continuous weighing in analytical chemistry has recently attracted the attention of many workers. The recent work of Duval and his associates has sometimes even challenged the reliability of well established data collected on the basis of traditional methods of gravimetric analysis. New compounds have also been discovered by this method and this has yielded several new methods of determinations. The assembly devised for such a purpose, automatically traces on a photographic paper a curve correlating the temperature or time with the gain or loss in weight of a material while being heated. This set up is, however, complicated and relatively expensive.

The present paper describes a very simple device which can be easily fabricated and is reasonably accurate. The apparatus consists essentially of a McBain-Baker Quartz fiber spring balance, the springs being wound by an automatic device and calibrated before use. The sensitiveness (stretch) of these springs ranges from 8 cm. to 10 cm. per gram weight. Hook's law is well followed in this range. The load that is ordinarily employed is about 0·3 g. By the use of a reference rod of quartz, the effective length of the spring to be measured by means of the travelling microscope (accuracy 0·001 cm.) is reduced to a minimum. Quartz or platinum buckets suspended by long rods are used to hold the substance under investigation.

The spring and the bucket are housed in a vertical silica tube supported by a suitable clamp and stand. The bucket portion is easily inserted in a tube furnace closed at one end. The furnace can be heated up to 1000°C., the rate of heating being regulated by means of a 'Variac'. Optimum rate of heating is found to be 3°-5°C. a minute. The temperature of the substance inside the furnace is read by a chromel-alumel thermocouple in a silica sheath hung close to the bucket.

The loss or gain in weight of the substance under investigation is followed by means of the travelling telemicroscope as already indicated. The results obtained are finally plotted having temperature (time) along the X-axis and the difference in weight along the Y-axis. The curves thus obtained are then interpreted and discussed.

20. DR. NARASIMHA SASTRI (Waltair) (In Absentia): *Photochemical Methods in Chemical Analysis.*

Many catalysed reactions have been used as the bases of several volumetric and colorimetric determinations. Although light has been known to catalyse many chemical reactions, such photocatalysed reactions have not been used for long for analytical determinations. It is only within recent years that the photochemical action of light has been pressed into useful service in analytical chemistry. It is proposed to review this work in this paper.

GROUP III (MICRO, SEMI-MICRO, ULTRA-MICROANALYSIS; SPOT ANALYSIS; CHROMATOGRAPHY)

21. DR. ASIMA CHATTERJEE, (MISS) ANIMA CHOUDHURY AND SRI SUNILKUMAR TALAPATRA (Calcutta): *Chromatographic Resolution of Natural Coumarins.*

Resolution of a mixture of coumarins, furocoumarins and chromenocoumarins, their derivatives and isomers has been possible by the application of paper chromatography technique (Riedl and Neugebauer, *Monatsch*, 1952, *83*, 1083). But very little studies have been made on the separation of their mixtures by column chromatography. Späth and Kainrath (*Ber*, 1937, *70*, 2272) first reported that limettin (5-7-dimethoxy coumarin) can be isolated from noncrystallisable Calabrian bergamot oil by its chromatography over Al_2O_3 using benzene and petroleum ether as the eluent. Later Caldwell and Jones (*J. Chem. Soc.*, 1945, 540) have shown that limettin, isopimpinellin and 5-methoxy-7-geranoxy-coumarin present in West Indian lime oil can be separated in pure state by their chromatography over "Birlec alumina". Schmid (*Helv. Chim. Acta*, 1947, *30*, 1661) has purified the acetates of 4-methyl-5-hydroxy-7-methoxy-coumarin and of 4-methyl-7-hydroxy-5-methoxy-coumarin by chromatographing the mixture over alumina. These are the few informations which are available in the literature on column chromatographic separation of coumarins.

The present authors wish to report here about the studies on chromatographic resolution of several natural coumarins on Tswett columns. It has been possible to develop a suitable column chromatography technique for the separation of a mixture of coumarins, furocoumarins, chromeno-coumarins, their epoxides and other derivatives occurring in nature. This method has proved very successful in isolating natural coumarins which do not crystallise out from crude plant extracts and which are also susceptible to decomposition or isomerisation when tried to isolate by saponification following the method of Spath. The following mixtures of coumarins (50·0 mgs. of each) have been successfully resolved using Al_2O_3 in column No. 2 (1·7 cm×30 cm):

(*a*) Coumarin and umbelliferone.
(*b*) Coumarin and methyl umbelliferone.
(*c*) Umbelliferone and methyl umbelliferone.
(*d*) Coumarin, umbelliferone and methyl umbelliferone (used benzene as the eluent).
(*e*) Coumarin, bergaptene and xanthyletin.
(*f*) Psoralene and bergaptene (used first benzene and then a mixture of benzene and ethyl acetate 97·5 : 2·5% as the eluent).

With the application of this technique it has been possible to isolate the coumarins, marmesin, marmin and umbelliferone from the crude extract of Aegle marmelos Correa as also the coumarins, furocoumarins and coumarin epoxides present in the seeds of *Heracleum nepalense.*, using first benzene and then a mixture of benzene and ethylacetate in varying proportions. For quantitative separation of the coumarins rechromatography is necessary. It has been observed that benzene and a mixture of benzene and ethylacetate are excellent eluents for coumarin series. It has been further noticed that umbelliferone and phenolic coumarins are strongly absorbed in the column and can be very difficultly eluted out with boiling ethyl acetate or boiling chloroform. They (if fluorescent) can readily be detected on the column by ultraviolet light and in some cases by brushing it with ferric chloride. They are best eluted out of the column by extruding it, cutting out the zones where they are absorbed and by subsequent refluxing these zones with boiling methanol or ethyl acetate. Further improvements on this technique for its general applicability in the field of natural coumarins are in progress.

22. Sri M. L. SEN GUPTA (Calcutta): *Chromatography of Fats and Oils.*

Chromatographic methods have been applied to fats and oils with three broad objects: (1) Separation of the unsaponifiable constituents which include the fat soluble vitamins, the steroids, phospholipids, and pigments; (2) Separation of the fatty acids or their esters to get individual components in a pure form, or to get qualitative and quantitative idea of the fatty acid composition, and lastly, (3) Concentration and isolation of autoxidised fractions of unsaturated fatty esters to establish the mechanism of autoxidation itself. The adsorbents useful in this field comprise alumina, silicic acid and charcoal. Most of the unsaponifiables, the ethyl or methyl esters of the fatty acids, and the autoxidised unsaturated fatty esters have been separated on columns of alumina. Alumina however is a rather strong adsorbent for the fatty acids, the desorption or elution is difficult; in this case charcoal has proved useful. Clay-base adsorbents like fuller's earth, floridin, have been used on a minor scale in the separation of vitamin A from the unsaponifiables of fish liver oils.

As solvents, hydrocarbon solvents like petrol ether, benzene have been most useful for the unsaponifiables, fatty esters etc., during adsorption, the development and elution being achieved by incorporating small quantities of diethyl ether, chloroform, or benzene. Absolute alcohol and chloroform are used in the separation of fatty acids on columns of charcoal. In partition chromatography on silica gel with the lower members of the fatty acids, a mixture of furfuryl alcohol and pyridine has been used as the supported phase and hexane as the mobile phase.

As to techniques, elution development has been practised more than any other method. The techniques of frontal analysis, displacement development, or partition chromatography have been used mainly on fatty acids, although here also the elution technique has achieved some spectacular results. Partition chromatography on paper has not found much favour with fats and oils except in isolated cases, such as in the separation of the lower fatty acids, the different forms of tocopherol, and some steroids. Elution chromatography on the other hand has been applied in the separation of vitamins, pigments, the fatty esters, autoxidised products etc. Purest samples of the esters of long chain unsaturated acids like methyl oleate, linoleate, linolenate or arachidonate have been prepared by using long alumina columns with petrol ether, and petrol ether-diethyl ether mixture as solvents by elution development.

23. DR. S. K. DUTTA (Calcutta) : *Semi-micro Paper Chromatographic Analysis of Nucleotides and the Heterocyclic Nitrogenous Bases in Nucleic Acid.*

The nucleic acids, analysed, were isolated from calf thymus gland, herring roe, mouse sarcoma, yeast, *M. phlei*, and *Sarcina lutea*. The nucleic acids from mouse sarcoma, *M. phlei*, and *Sarcina lutea* were mixtures of both pentose-nucleic acid and desoxypentose nucleic acid and so they were first fractionated properly and then subjected to analysis.

Nucleotides were liberated from the nucleic acid by hydrolysis with sodium hydroxide, mild hydrochloric acid or sulfuric acid at suitable temperatures. The free purines and pyrimidines were liberated by hydrolysing the nucleic acid with formic acid, perchloric acid, and triflouroacetic acid under suitable conditions. The merits and demerits of the different hydrolysing agents were studied.

In preference to other papers Whatman No. 1 filter paper was used for all these analyses. The solvents were acidic n-butanol with monomethyl ether of ethylene glycol, ammonical n-butanol with monomethyl ether of ethylene glycol, and 65% iso-propanol which was 2N with respect to HCl. Both ascending and descending one dimensional chromatograms were developed at room temperature in darkness.

After the development, the locations of the nucleotides and the heterocyclic nitrogenous bases were perfectly done with ultra-violet (253mμ) photography using suitable filters. Also they could be located and marked by using flourescent screen on ultraviolet light.

The elution of the materials from the chromatograms was better done with 0·1N HCl solution at 37°C. Microanalysis of N and P and the complete ultra-violet absorption curves of the different eluates were recorded to characterise the substances. From absorption peaks at the proper wavelength of the eluates and of standard nucleotides and purines and pyrimidines, the quantitative estimations were done in the chromatograms.

The method could estimate as little as 5μg. of the nitrogenous bases. Statistical calculation showed that the probable error of difference (R ±) were not significant.

24. Sri N. N. SHARMA and Dr. R. C. MEHROTRA (Allahabad) (In Absentia) : *Semi-micro Applications of Cerate Oxidimetry.*

The applications of ceric salts as volumetric reagent have been studied systematically by Willard and Young (1928-1936) and by Furman and collaborators. Willard and Young applied the reagent to the determination of a number of organic compounds by oxidation. They found that formic acid is not oxidised at all by ceric sulphate and many other organic acids, e.g., tartaric, malonic and malic acids are oxidised to a definite degree under controlled conditions. Empirical methods for the determination of a number of organic acids were described based on the above observation. However, it has been found by the authors that not only formic acid is quantitatively oxidised by ceric sulphate, but many other organic acids (tartaric, malonic, malic, glycollic, benzoic, phthalic, salicylic, fumaric, maleic and citric acids) are oxidised completely to carbon dioxide and water by ceric sulphate in the presence of a sufficient concentration of sulphuric acid. The oxidation of all these compounds being quantitative, it has been possible for the first time to employ the reagent on a semi-micro scale. It has also been possible by the new technique to analyse quantitatively mixtures of organic compounds—like oxalic and citric acids, formic and acetic acids and many others.

Further, ceric sulphate in the presence of a large concentration of sulphuric acid has been found a very valuable reagent for the volumetric determination of a number of organic reagents used as precipitants for metallic ions. It has been possible to estimate very small quantities of magnesium, aluminium, zinc, zirconium and thorium by this procedure, a special advantage of which is the comparative quickness with which the determination can be completed.

XI. TEXTILE CHEMISTRY.

Chairman : Dr. B. K. Vaidya (Ahmedabad).

1. Prof. G. M. NABAR (Bombay) (In Absentia) :

Textile Science is a comparatively modern subject and the phenomenal rise of the Textile Industry in the 19th century is not necessarily linked up with the development of science. It is most creditable that in spite of lack of knowledge of the fundamentals, the industry reached a high degree of practical perfection. One of the greatest obstacles to the intelligent understanding of textile processes was the lack of precise knowledge of the physical and chemical properties of the various textile fibres on which their behaviour depends. The technical practice is now slowly being translated into scientific processes and hence the subject of Textile Chemistry has assumed an enormous size. The real change in outlook took place after World War I. Today we see the complicated practical phenomenon, connected with the arts of dyeing, bleaching, finishing and printing, being explained on the basis of the fundamental sciences. These changes in the outlook have naturally resulted in highly specialized schools of thought in this field. Thus we read and hear about groups of men actively engaged in researches, restricting the scope of their investigation to a limited field such as chemistry of cellulose, theories of dyeing, etc., and meeting together to hold symposia to discuss the results of their researches and also their difficulties. Such symposia are naturally restricted to a very narrow field of textile chemistry.

We in this country have not reached that degree of specialization mentioned above. The number of men engaged in any kind of investigation in the field of Textile Science is limited and at the moment it is difficult to hold such specialized symposia on topics in Textile Chemistry. It will therefore be understood why it has been decided to hold this symposium on Textile Chemistry. Those who visualise the enormity of the subject of Textile Chemistry will realise that it is a misnomer but no other more suitable name could be thought of, in the present circumstances. It is however earnestly hoped that in not too distant a future with the development of the various Textile Research Associations and University Departments in the country, it will be possible to hold specialized symposia in the field of Textile Science.

2. DR. V. B. CHIPALKATTI and DR. J. A. MASARGUPPI (Delhi) : *Some Theoretical Implications of the Viscosity of Cellulose Solutions.*

Einstein[1]'s fundamental equation correlating the specific viscosity with the concentration and density of a polymer in solution is discussed and it is shown that cellulose solutions do not obey the expected behaviour. A brief review is made of the various theories regarding the state of cellulose in solutions and it is suggested that there is still a divergence of opinion as to whether cellulose is molecularly or micellarly dispersed in solution.

The authors' work on the fluidity of cellulose in phosphoric acid is presented and an attempt is made to interpret the data in the light of the above background. The following points are noted :—

(*a*) There is some difference in the manner in which the present authors[2] dissolve their cellulose and that of Ekenstamm,[3] Stamm & Cohen,[4] Hiller & Pacsu[5] and Jorgensen[6] etc. The present authors dissolve their cellulose by macerating thoroughly in water so that viscosity readings can be taken from the first half hour. The latter take a time of one hour to 7 hours before viscosity readings are taken.

(*b*) The rate curve for specific viscosity (η sp) vs. time (t) obeys an emperical relation $\eta\,sp = kt^n$, where k and n are constants.

(*c*) The above relation holds good both in the very early stages of the degradation as well as in the later stages—even after 100 hours.

(*d*) The rate curve has linear stepwise portions when log ηsp is plotted against log t.

(*e*) The exponential equation stated above applies equally well to the data of Hiller & Pacsu (*ibid*).

The significance of the above data is discussed and it is suggested that it is not correct to assume molecular dispersion of cellulose in solution. The solvent breaks up the hydrogen bonds between chains of cellulose molecules as well as the 1 : 4 glucosidic links. Neither all the hydrogen bonds nor all the glucosidic bonds are simultaneously available for the solvent-cellulose reaction. Their accessibility is limited and the course of the rate curve is indicative of the manner in which cellulose structure is continuously opened up during the degradation reaction. That the opening up process is similar both for the initial reaction when the D.P. is high and the final stages when the D.P. is low is significant and suggests that the micellar structure persists even after prolonged degradation of cellulose in phosphoric acid. It does not seem to be necessary to assume any special acid sensitive links such as the acetal links as suggested by Hiller & Pacsu nor to assume complete molecular dispersion in solution.

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3. DR. M. V. NIMKAR (Ahmedabad) : *On Theories of Moisture Absorption.*

Textile fibres when exposed to humid atmospheres absorb varying quantities of moisture. The amount of moisture absorbed depends on the structure of the fibres on the one hand and on the external conditions prevailing on the other. The absorbed moisture products profound changes in the physical and mechanical properties of fibres. These in turn affect the serviceability of the textile material. The diffusion of water vapour through the textile material determines the body comfort afforded by the material. This in turn is dependent upon the moisture absorbancy of the fibres. Thus the success of the manufacturing processes and the overall performance of the textile material depends largely upon its moisture relationships.

Based upon the study of these relationships, various theories of moisture absorption have been put forward from time to time. A broad survey of the literature reveals that these theories can be classified into three groups.

(1) Capillary theories—i.e. theories based upon the capillary structure of the fibres.
(2) Adsorption theories.
(3) Solution theories.

In the present paper, these theories are discussed critically. Finally an attempt is made to co-ordinate all the three theories on the basis of a variety of data available on the moisture relationships of textile fibres.

4. DR. D. B. DAS (Calcutta) (In Absentia) : *Estimation of Pentosans in Cellulosic Materials.*

Cellulosic materials contains α-cellulose, pentosans, hexosans and polyuronides. The usual method of evaluating the pentosan content in these materials is to estimate first its total 'furfural' content,[1] carbondioxide value[2] and also the furfural content of the α-cellulose made[3] from this particular source of cellulose. The furfural due to pentosans is then calculated from :—

'Furfural' due to pentosans ≡ Total "Furfural"—

'Furfural' due to polyuronides as determined from polyuronide CO_2 and Norris & Resch.[4]	'Furfural' due to α-cellulose prepared from the source.

The pentosans are then calculated from Kröbers table[5] or according to Doree.[5] In the above equation it is assumed that α-cellulose is free from pentosans or polyuronides and that all the furfural coming from α-cellulose is derived from the polymer whose building units are glucose only. From paper chromatographic analysis carried out in this Laboratory it has been shown[6, 7, 8] however that jute α-cellulose prepared by the conventional method contains about 3% furfural and is invariably associated with pentoses such as xylose and arabinose. This was later on supported by Adams & Bishop,[9] by a different method who have also shown that α-cellulose prepared from other sources of cellulosic materials studied except cotton invariably contained pentoses. Recently Das, Mitra & Wareham[10] by means of formic acid method of hydrolysis[11] developed in this Laboratory have shown chromatographically that even cotton α-cellulose contains pentoses (xylose and arabinose) which has been also confirmed by Adams.[12] These observations have not only an important bearing on the so far accepted structure of cellulose but also has resulted a serious problem in the estimation of pentose in the cellulosic materials.

The furfural content of glucose is reported[13] to be 0·62% and considering the observation of Das, Mitra & Wareham[14] that if jute α-cellulose (about 3% furfural) is treated with 10-5% NaOH alternatively for 8 times, the furfural value of the product although drops to 0·75%, the product still contains readily detectable pentoses, it is suggested here that if the furfural due to pentoses present in cellulosic materials is calculated from the following equation much nearer to the true value than that have hitherto been possible can be obtained.

'Furfural' due to pentosans ≡ Total "Furfural"—'Furfural' due to—0·62
polyuronides as
determined from
polyuronide CO_2
and Norris &
Resch.[4]

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5. DR. E. H. DARUWALLA (Bombay): *Studies in the Transfer of Dyes from Thickener to Fibre Substance during Steaming.*

Although the operation of printing of textile materials has been carried out to a very large extent, because of the complexity of the process the fundamentals underlying the various steps involved in printing are but little studied.

An attempt has been made to simplify the normal printing process so that the characteristics of the transfer of dye from the applied printing paste to the fibre substance may be studied quantitatively and systematically under standard conditions. Employing this simplified technique the transfer behaviour of selected direct cotton and acid dyes has been studied in detail. The type of thickener used and the presence of electrolytes and hygroscopic agents in the printing paste have been found to influence the rate of dye transfer and the proportion of the dye transferred at equilibrium to a considerable extent. The results are explained on the basis of the magnitude of the "negative potential barrier" at the cellulose-thickener interphase and also in terms of the distribution of water between these two phases.

The study has also been extended to another fibre substance such as cellulose acetate, and the characteristics of the dye transfer of selected disperse and soluble acetate rayon dyes have been investigated. The effect of chemical structure and particle size of the dye and the presence of electrolytes and swelling agents for the fibre substance has been examined for appropriate conditions of application. In general there is a close resemblance between the dyeing behaviour of each class of dye and the corresponding transfer behaviour during steaming.

6. DR. B. K. VAIDYA (Ahmedabad) : *Photodecomposition of some Basic and Azo Dyes.*

Several types of reactions were noticed to occur when dyes of the triphenylmethane class in form of purified oxalates were exposed to sunlight or to the light of carbon or mercury vapour arcs. In powder form, after a few weeks to a few months exposure in sunlight ieuco form of the dyes could be identified and isolated. Dealkylation also occurred in dyes having the p. amino hydrogens substituted by alkyl groups. In solutions, the oxidation process was favoured and Michler's types of ketones were formed. The tendency for the latter type of reaction was however restricted to polar molecules like Malachite Green, the symmetrical non-polar molecules like Crystal Violet and Rosaniline showing practically no ketone formation. The quantum efficiency of the photoprccess in solution in presence of air was found to be extremely low being of the order of one molecule for a million quanta of the absorbed radiations.

The direct dyes of the azoic class were generally observed to undergo an oxidation process in light which resembles their thermal oxidation in presence of an oxidising agent. Existence of intermediate oxidation compounds have been postulated but they have so far not been isolated. Spectrophotometric and tintometric studies on dyed cotton samples accompanied by parallel chemical estimations however indicate that the preliminary loss of colour occurs before the rupture of the azo linkage takes place, an indirect evidence being obtained thereby of the presence of intermediate colourless products probably of the peroxide or the azoxy types.

Either class of dyes as well as those of the nitrogroup may have their oxidation process markedly retarded in solution or on fabric in the presence of copper sulphate, the retardation factor relative to the reaction without copper sulphate ranging from 1·2 to 1·5 for many azo dyes with the exception of the colours of the chlorazol sky blue type having—OH groups in favourable positions in the molecule for the formation of a copper complex. In such cases the retardation factor may go up to 7. In the triphenylmethane class of dyestuffs the retardation to the extent of 1·5 to 2·5 times was common while for some nitro dyes, copper sulphate did not affect the rate of change but considerably advanced the insolation period.

7. DR. A. B. SEN GUPTA (Calcutta) : *Some Characteristic Chemical Properties of Jute in Relation to Bast Fibres of the Hibiscus Group.*

A number of bast fibres closely allied to jute can be successfully processed on jute mill machinery and the most common of these substitute fibres are derived from the Hibiscus plant, usually from the species known as *H. cannabinus*. The fibres from *H. cannabinus* are described by a variety of different names but, in India, are usually known as either Mesta or Bimli and in other countries as Kenar. The quality of Hibiscus fibres from a spinning point of view varies similar to that of jute but, generally speaking, this fibre is coarser and more brittle than jute and, as a result, is not suitable for the spinning of fine yarns. There is however, very little difference in the chemical composition of jute and the Hibiscus fibres so far as the major constituents other than lignin are concerned.

In the work described, a particular study has been made of the relative proportions and mode of occurrence of the characteristic groups namely, acetyl, carboxyl and methoxyl, which are generally regarded as of minor importance, with a view to obtaining some additional evidence for differentiating jute from the Hibiscus fibres. In addition, the lignin contents of these fibres have been re-examined with a more accurate procedure recently made available in order to ascertain whether the reported difference in lignin contents was really significant.

From an analysis of the several varieties of each of the fibres examined it has been found that the difference in lignin and holocellulose contents of jute and other substitute fibres are significant. Both the acetyl content and the total acidity, i.e., the combined acidity due to acetic acid and uronic acid of the substitute fibres, are appreciably higher than the corresponding values obtained from jute. No definite conclusion could be drawn from the variation in the carboxyl contents occurring in different forms. It was however found that the amount of methoxyl associated with the lignin fraction is relatively high and that associated with the carbohydrate is low in jute when compared with other Hibiscus fibres. It seems possible therefore that, from the variations in the values mentioned above, jute can be differentiated from other fibres in the Hibiscus group.

8. Dr. I. B. CHAKRAVERTI (Calcutta) : *Preferential Adsorption in Jute with Particular Reference to Chemical Finishing Operation.*

Jute has been observed to possess selective affinity for many organic proofing and finishing materials as a result of which these compounds are preferentially adsorbed by the fibre from their aqueous solutions. The importance of such absorption in relation to wet processing technology when applied to jute has been discussed. Quantitative measurement of sorption characteristics was attempted with a mildew-proofing agent, salicylanilide, and this first necessitated the development of a reliable method of estimation of salicylanilide in jute based on the indophenol reaction of phenols with p-phenylene diamine as proposed by Fancutt and Twiselton.

The preferential adsorption of the compound has been shown to originate from the potential functional carboxyl and phenolic hydroxyl group of the polyuronide and lignin fractions of jute. Progressive removal of these functional groups leads to a reduction of the tendency. When both lignin and polyuronides are eliminated the resulting alpha-cellulose of jute exhibits preferential adsorption only to a slightly greater extent than cotton cellulose which does not show this tendency towards the mildew-proofing agent. The phenolic hydroxyl groups seem to be mainly responsible for the adsorption because wool and silk which do not contain either hemi-cellulose or lignin but possess phenolic hydroxyl group (e.g. from tyrosine) exhibit this tendency to a marked degree, although some absorption might be due to the free carboxyl group of the amino acids.

Other lignocellulosic fibres examined such as flax, sisal, sunn hemp, urena lobata also exhibit selective affinity for salicylanilide in various degrees. No linear correlation could however be observed between the lignin content and the degree of preferential adsorption of the various lignocellulosic fibres examined.

Preferential adsorption of two insecticidal compounds, DDT and pyrethrins synergised with piperonyl butoxide, has also been observed. Possible mechanism of the preferential adsorption has been discussed. A number of remedies have been suggested to reduce the unevenness of deposition of the proofing compound on the fibre arising out of such adsorption.

9. **Sri M. L. Sen Gupta** (Calcutta) : *Sulphated Fatty Alcohols as Textile Auxiliary Agents.*

The use of sulphated fatty alcohols of the Gardinol Type as textile assistants covers a wide field; the properties responsible for this are their stability to hard waters, alkali and dilute acids. The lower alcohols are usually favoured as wetting agents and the higher ones as detergents.

For their industrial preparation, the alcohols are to be procured at an economic rate. They are usually obtained from certain natural waxes as spermaceti or by the hydrogenation of fatty acids or esters.

The technique of their production is dependent on the mode of sulphation. This varies with the nature of sulphating agent which may be concentrated sulphuric acid, oleum or chlorosulphonic acid. The sulphonated product is to be carefully neutralised and suitably adjusted to contain adequate amounts of inorganic salts.

In this paper the above conditions have been studied and discussed.

10. **Dr. T. Radhakrishnan** and **Dr. P. C. Mehta** (Ahmedabad) : *Laboratory Tests of Weavability.*

The possibility of using laboratory evaluations of sized yarns in predicting their weavability is of both practical importance and theoretical interest. Recent work has shown that the conventional measurements of single-thread tensile strength and elongation at break have little correlation with the rate of warp breakages in weaving. An examination of the nature of stresses imposed on the yarn during weaving shows that this is not a surprising result. The yarn is seldom subjected to a load or a stretch anywhere near the rupture value. Instead, it is subjected, at a high frequency, to a repeated cycle stress and relaxation, the stress usually not exceeding a fraction of the breaking strength or elongation. Superimposed on this is the abrasion of the sized warp against the healds and reeds and against its neighbouring yarns. It is expected that cyclic loading tests to get the elastic performance characteristics of sized yarn together with tests for its abrasion resistance should give us a better understanding of its weavability. An attempt is made in this paper to correlate laboratory data on the elastic performance and abrasion resistance of yarns sized in different ways with corresponding data of warp breakages obtained from large scale working of these yarns.

11. **Sri J. B. Sane** (Bombay) (In Absentia) : *Role of a Textile Chemist in the Industry.*

The cotton Textile Industry is the premier Industry of India. The wet processing of the cotton textiles is a necessary addition to the production of cotton fabrics. Among the various products used in this industry are :

(1) Cellulose in the form of raw cotton, yarn and woven cloth.

(2) a number of chemicals such as enzymes, starches, softeners, mineral acids and alkalis, bleaching agents such as chlorine and hydrogen peroxide, organic chemicals such as dyestuffs and various auxiliary products of a like nature.

(3) a number of machines required in the processing Industry—wherein a variety of materials of construction is used.

It is necessary for a chemist to know the methods of testing the purity of all the above and judge for himself the nature, the extent of the impurities to be tolerated and these to be avoided. Regarding the materials of construction we should know the suitability of certain materials for a particular process in view.

Another very essential chemical is water; and the chemist must know the properties of water that is available and must know the impurities, which can be tolerated and those that cannot be and should know the methods to render the water harmless for a particular process.

A textile chemist has to be his own engineer as far as his machines are concerned. He must know the various parts and their maintenance. He must know the speed and performance of his machines.

A textile chemist has to know the sequence of the processes and the methods adopted to achieve uniformity. In the mass production a yard of cloth processed one day must be as good as the cloth processed previously and as good as the one to be processed next day. He has also to establish controls at every stage to achieve this uniformity. He has to set up certain standards of some measurable quantities such as tensile strength, whiteness of bleached goods, absorbancy of goods to be subsequently dyed or printed; fastness of dyed and printed materials and the final finish and handle required. He must also know the methods of final get up and packing so as to attract the attention of the public.

Then comes the final examination and check up of the finished fabrics and ascertain the tolerances as established by methods of quality control.

In carrying out all the above, a textile chemist as a man must be cost-conscious. He has now to satisfy the economic standards. He has to establish optimum conditions in the production so that his cost is low and the quality as good. Thus he has to establish a check on his labour, stores and overhead.

He is concerned with getting more from his machines, with minimum labour and with minimum consumption of stores. He has to maintain comparatively small indirect labour and minimum steam and water.

As far as he is connected with running his department, he must know the factory laws and laws affecting the labour. He has also to know how to get along with his colleagues. Lastly he must be uptodate with the latest development in the line and must know how to impress his superiors by good expression and pleasant manners.

It is very difficult to get such a textile chemist possessing all these attributes. Only years of experience can equip a chemist as above. But it is quite possible to train a budding textile chemist so that he realizes what is required of him when he enters the Industry. Our young men to-day know much about the theoretical side of our subject but lack greatly the other practical aspects of the line. In order to prepare him for such a job, more stress must be given to the practical training period when the whole programme of training must be developed and carefully watched by the professors along with the Managers of the factories, and unless that is done, the Industry will continue to pay during the initial periods of the employment.

12. In the discussion that followed, Dr. K. S. G. Doss (Kanpur), Dr. A. M. Trivedi (Ahmedabad) and Dr. D. C. Tapadar (Hazinagar, W. Bengal) also participated.

XII. SYNTHESIS OF STEROIDS.

Chairman : Dr. D. K. Banerjee (Bangalore).

1. Dr. D. K. BANERJEE (Bangalore) : *Stereospecific Syntheses of trans-(β)-Hydroxy-8-Methyl-4,5-(4′Methoxybenzo)-Hydrindane and* d, 1-*Equilenin Methyl Ether.*

6-Methoxy-α-tetralone (I) on formylation with ethyl formate in the presence of dry sodium ethoxide in benzene gave a solid 2-hydroxy-methylene-6-methoxy-α-tetralone (II), m.p. 67-68°, in 99% yield. A solution of the hydroxymethylene derivative in glacial acetic acid on treatment with hydroxylamine hydrochloride yielded the isoxazole (III), m.p. 57°. The latter on treatment with sodium ethoxide could be converted into the β-keto nitrile (IV), m.p. 96-98°, which was methylated by refluxing with potassium t-butoxide and methyl iodide to give 2-methyl-2-cyano-6-methoxy-α-tetralone (V), m.p. 70°. The overall yield in these steps was 83%. The Stobbe condensation of V with dimethyl succinate furnished methyl 1-keto-8-methyl-4, 5-(4′-methoxybenzo)-hydrindene-3-carboxylate (VI), m.p. 114-115°, in 42% yield; U.V., λmax 303 mμ (log ε 4·2); I.R. 5·67μ, 5·8μ. The unsaturated keto ester (VI) was hydrolysed by refluxing with a mixture of barium hydroxide in alcohol and water under nitrogen and the crude acid thus obtained was evaporatively distilled under vacuum in an atmosphere of nitrogen, expecting that the decarboxylation would occur during distillation. However, an acid was obtained as a light pink solid, m.p. 109°. The structure (VII) has been assigned to it on the basis of U.V. data—λmax 254 mμ (log ε 4·01). The crude acid was decarboxylated by refluxing with a mixture of pyridine hydrochloride and hydrochloric acid to give a neutral oil in 75% yield. The oil was chromatographed on an acid washed alumina column using n-hexane-benzene (1 :3) and benzene as eluting solvents. The light yellow solid, m.p. 129-130°, λmax 264·5 mμ (log ε 4·2), eluted by n-hexane-benzene, was obviously the β, γ-unsaturated ketone (VIII), and the low melting fraction, m.p. 60-62°, λmax 227 mμ (log ε 4·2), λmax 279 mμ (log 3·5), eluted by benzene, was the α, β-unsaturated ketone (IX). The α, β-unsaturated ketone, m.p. 60-62°, was catalytically hydrogenated in alcoholic solution over 10% palladium charcoal to furnish an oil, λmax 279 mμ (log ε 3·6). The oil, which could not be induced to crystallise, was demethylated by boiling with mixture of 48% hydrobromic acid and acetic acid under nitrogen. On purification by evaporative distillation the phenolic ketone (XI) was obtained as a colourless crystalline solid, m.p. 155-156°. This melting point agrees with the α-isomer obtained by Bachmann and Thomas [J. Am. Chem. Soc., *64*, 94 (1942)] following a different route. The α, β-unsaturated ketone (IX) is obviously formed from the unsaturated keto ester (VI) by the shifting of the ethylenic linkage from $\triangle^{3,9}$ to $\triangle^{2,3}$ position during the saponification of VI or decarboxylation of the acid obtained thereof. The new asymmetric centre formed at C_9 as a result of this migration of the double bond should assume the more stable *cis* configuration, so that the α-isomer of Bachmann and Thomas must have *cis* configuration. Catalytic hydrogenation of VIII yielded an oil, from which no crystalline product could be obtained even after chromatography on an alumina column, and most probably consists of a mixture of the *cis* and *trans* isomers of the reduced ketone (X and XII). This, however, could be expected in view of Johnson, Petersen, and Gutsche's experience in the synthesis of equilenin [J. Am. Chem. Soc., *69*, 2942 (1947)].

With a view to achieving the stereospecific synthesis of the *trans*-hydrindane ring system, the unsaturated keto ester (VI), which has the double bond fixed at $\triangle^{3,9}$ position, was chosen as the suitable starting material. It was further considered that the formation of some *cis* isomer during the reduction of the β, γ-unsaturated ketone (VIII) might have been due to the presence of the ketone group. In order to eliminate the influence of the keto group, VI was reduced with sodium borohydride to give the hydroxy unsaturated ester (XIII), m.p. 117-118°; U.V., λmax 302 mμ (log ε 4·1); I.R., 2·81μ, 5·82μ, in 99% yield. The latter was saponified with barium hydroxide to furnish the corresponding acid (XIV), m.p. 215-216° (d.), in 90% yield, which was decarboxylated by heating under nitrogen at 220-230°. The neutral unsaturated alcohol (XV), m.p. 149-150°, λmax 266 mμ (log ε 4·1); thus obtained (74%), was catalytically reduced to yield *trans*-1(β)-hydroxy-8-methyl-4, 5-(4′-methoxybenzo)-hydrindane (XVI), m.p. 75°, λmax 280 mμ (log ε 3·5). The unsaturated alcohol (XV) could also be obtained by the reduction of the β, γ-unsaturated ketone (VIII) with sodium borohydride. The β-configuration (steroid nomenclature) of the hydroxyl at C_1 has been assigned on the basis of the observation that the 17-keto steroids are invariably reduced by lithium aluminium hydride to 17-hydroxy steroids with β-orientation [Fieser, Experientia, *6*, 312 (1950)]. Finally XVI was oxidised with pyridine-chromic acid complex to furnish the crystalline ketone (XII), m.p. 112-113°, in 37% yield. The latter was demethylated with hydrobromic-acetic acid mixture to yield the phenolic ketone (XVII), m.p. 208-210°. These melting points are in close agreement with those described by Bachmann and Thomas for the β-isomer, which should, on the basis of this work, be considered as the *trans* isomer.

Several methods for the synthesis of equilenin (XXIII, R = H) have been described by different workers [Bachmann *et al.*, J. Am. Chem. Soc., *62*, 824 (1940); *73*, 3660 (1951); Johnson *et al.*, *ibid.*, *69*, 2942 (1947); *72*, 505 (1950)], but none of these is stereospecific. By the application of the aforementioned procedure for the synthesis of the benzohydrindane derivative a stereospecific synthesis of d, l-equilenin methyl ether has been realised. The tetracyclic unsaturated keto ester (XVIII), previously prepared by Johnson, Petersen, and Gutsche (*loc. cit.*), was reduced with sodium borohydride to give methyl 3-mehoxy-17 (8)-hydroxy-14, 15-dehydroequilenane-15-carboxylate (XIX), m.p. 178° λmax 230 mμ (log ε 4·45), λmax 265 mμ (log ε 4·3), μmax 320 mμ ,log ε 4·2) in 92% yield. The unsaturated hydroxy ester (XIX) was saponified with barium hydroxide and the corresponding acid (XX), 270-273° (d.) was obtained in 87% yield. The decarboxylation of the acid was carried out in small quantities by heating it mixed with glass powder for a short time at 300-310° under nitrogen. 3-Methoxy-17 (β)-hydroxy-14, 15-dehydroequilenane (XXI), m.p. 187-190°, λmax 235 mμ (log ε 4·45), λmax 255 mμ (log ε 4·42), λmax 263 mμ (log ε 4·05), λmax 303 mμ (log ε 4·43), λmax 291 mμ (log ε 4·01) λmax 332 mμ mμ (log ε 3·18), λmax 347 mμ (log ε 3·0), was obtained in 67-83% yield. The catalytic reduction of XXI yielded the saturated alcohol (XXII), m.p. 180°, λmax 228 mμ (log ε 4·7), λmax 278 mμ (log ε 3·66), λmax 324 mμ (log ε 3·29), λmax 339 mμ log ε 3·36). Oxidation of XXII in the cold with sodium dichromate dihydrate and acetic acid in benzene-acetic acid solution furnished d, l-equilenin methyl ether (XXIII, R = CH_3) in 71% yield. The melting point of d, l-equilenin methyl ether, thus obtained, was not depressed by admixture with an authentic specimen.

Since strong evidence in favour of the *trans* configuration of the hydrindane moiety in equilenin has accumulated due to the work of Klyne [Nature, *161*, 434 (1948)] on molecular rotation differences and Bachmann et al [J. Am. Chem. Soc., *72*, 1323 (1950); *72*, 2527 (1950)] on epimerisation studies of some steroids and related compounds, and the lactams corresponding to desoxy equilenin and desoxy isoequilenin, this new stereospecific sequence of reactions for the formation of *trans-hydrindane* systems receives further confirmation.

2. Dr. P. C. DUTTA (Calcutta) : *On 11-Oxygenated Steroids.*

3. Dr. G. SINGH (New Delhi) : *Stereochemistry of Steroids.*

4. Dr. S. M. MUKHERJI (Hoshiarpur) (In Absentia) : *19-Nor-Steroids.*

5. Dr. M. S. NEWMAN (Ohio State Univ., U.S.A.) and

Dr. S. SWAMINATHAN (Madras) : *Synthesis of 1-Acetyl-6-oxo-8-a-methyl-3, 4, 6, 7, 8, 8 a—hexahydronaphthalene.*

The alkylation of 2-Methyl-1, 3-cyclohexanedione (I) with 1-diethylamino-3-butanone (II) in the presence of equimolar amount of Pyridine gave 70-75% yield of 1, 6-di-oxo-8a-methyl-1, 2, 3, 4, 6, 7, 8a-Octahydronaphthalene (III) (m.p. 47·5-48·5; $\lambda_{\text{max}}^{\text{EtoH}}$ 243 mμ; $\log_{10}$ ε 4·18; Dioxime m.p. 199-201°; mono-2, 4 DNP m.p. 186-187°; Di-2, DNP m.p.; 257-60°3. The conventional method of alkylation of I with the methiodide of II in the presence of sodium methoxide yielded little, if any, of III the major product being 2-(2′-carboxyethyl-3, 6-dimethylcyclohex-2-eneone (m.p. 47·5-48°; $\lambda^{\text{EtoH}}_{\text{max}}$ 242 mμ $\log_{10} \varepsilon$ 4·25; 2, 4-DNP m.p. 103-104°; Semicarbazone m.p. 195-196°). The bicyclic diketone III was unstable to aqueous alkali, being converted almost quantitatively into 3-(3′-carboxypropyl)-4-methyl-cyclohex-2-eneone (IV m.p. 78°; $\lambda^{\text{EtoH}}_{\text{max}}$ 238 mμ; $\log_{\cdot 10} \varepsilon$ 4·17).

Compound III when reacted with triethyl--orthoformate furnished 1-oxo-6-ethoxy-8a-methyl-1, 2, 3, 7, 8, 8a-hexahydronaphthalene (V; b.p. 101°/·1 mm.; $\lambda^{\text{EtoH}}_{\text{max}}$ 243 mμ; $\log_{10} \varepsilon$ 4·17; oxime m.p. 132·5-134°) in 85% yield. The enolether V when treated with hydrogen cyanide in the presence of triethylamine gave (50-55%) a mixture of the epimeric cyanohydrina (m.p. 152-156°; $\lambda^{\text{EtoH}}_{\text{max}}$ 242 mμ; $\log_{10} \varepsilon$ 4·3). The latter when dehydrated with a mixture of pyridine and phosphorus oxychloride gave a 60% yield of 1-cyano-6-ethoxy-8a-methyl-3, 7, 8, 8a-tetrahydronaphthalene (VI; b.p. 125-128°/·2 mm.; $\lambda^{\text{EtoH}}_{\text{max}}$ 232 mμ; $\log_{10} \varepsilon$ 4·08). This unsaturated nitrile proved unreactive towards methylmagnesium bromide. Compound III when reacted with hydrogen cyanide was converted quantitatively into an epimeric mixture of 1-cyano-1-hydroxy-6-oxo-8a-methyl-1, 2, 3, 4, 6, 7, 8, 8a-octahydronaphthalene (VII; m.p. 112-116°; $\lambda^{\text{EtoH}}_{\text{max}}$ 244 mμ; $\log_{10} \varepsilon$ 4·14). Attempts to dehydrate VII to the corresponding unsaturated nitrile failed.

Compound V reacted with acetylene in the presence of potassium tertiary amyloxide to give, besides IV, a 30-35% yield of a mixture of epimers of 1-ethinyl-1-hydroxy-6-oxo-8a-methyl-1, 2, 3, 4, 6, 7, 8, 8a-octahydronaphthalene (VIII; α-ethinyl epimer m.p. 171·5-172·5° $\lambda^{\text{EtoH}}_{\text{max}}$ 240 mμ; $\log_{10} \varepsilon$ 4·13; C=O absorption at 6·6 μ; C=C at 4·8 μ; —OH at 3μ; beta-ethinylepimer m.p. 145·5-147°; $\lambda^{\text{EtoH}}_{\text{max}}$ 240 mμ; $\log_{10} \varepsilon$ 4·16). The ethinyl carbinol VIII α when refluxed with 85% formic acid gave, besides VIII β, a poor yield of 1-acetyl-6-oxo-8a-methyl-3, 4, 6, 7, 8, 8a-octahydronaphthalene (IX) isolated as the dioxime (m.p. 200-202°). It was subsequently found that the reaction mixture obtained by reacting III with sodium acetylide in liquid ammonia followed by acidification contained considerable amounts of IX which could be isolated as the dioxime. This dioxime when decomposed with pyruvic acid gave IX (b.p. 85-88°/·002 mm. $\lambda^{\text{EtoH}}_{\text{max}}$ 246 mμ; $\log_{10}\varepsilon$ 4·28; Two C=O absorption peaks at 5·85 μ and 6 μ respectively in 80-90% yield.

6. Sri R. B. MITRA and Dr. B. D. TILAK (Bombay) : *Synthesis of a Thiophene Analogue of 3-Desoxyequilenin.*

In continuation of our study of the role which an activated 9 : 10-double bond in phenanthrene plays in chemical carcinogenesis, synthesis of thiophene analogues of sterols has been undertaken.

Synthesis of 3 : 4-(3-keto-2-methyl cyclopentano)-21 : 2 : 3 : 4-tetrahydrodibenzothiophene (I), a thiophene analogue of 3-desoxyequilenin, starting from 4-keto-1 : 2 : 3 : 4-tetrahydrodibenzothiophene (II) by a six-step synthesis is under way. The synthesis is analogous to Johnson *et al.*'s synthesis of 3-desoxyequilenin starting from 1-keto-1 : 2 : 3 : 4-tetrahydrophenanthrene.

Compound (II) was converted to 3 : 4-(5-carbethoxy-3-keto-2-methyl-5-cyclopenteno)-1 : 2 : 3 : 4-tetrahydrodibenzothiophene (III) in four steps in an overall yield of 48%. Conversion of the latter to (I) in 2 steps is in progress.

Section of Geology and Geography.

Chairman: SHRI V. P. SONDHA (Calcutta):

XIII. EVOLUTION OF CONTINENTS.

1. SRI J. SWAMI NATH (Geological Survey of India):

The study in Eastern Australia of the Tasman Geosyncline and its classification according to Kay (1951) has revealed the existence of eugeosynclines, miogeosynclines, epieugeosynclines and possibly an Exogeosyncline. The evidence* available indicates that the Australian Continent was evolved from west to east by a process of continental accretion, and the stratigraphic evidence also supports the hypothesis that the continents have evolved by interrupted dynamic processes leading to the reduction of oceanic areas through an intermediate 'island arc' stage.

2. SRI S. NARAYANASWAMI (Geological Survey of India): *Evolution of Pre-Cambrian Shield of Peninsular India.*

The centrifugal arrangement of (1) the Vindhyans, (2) the belt of Aravalli, Sausar, Gangpur and Iron-Ore Series rocks, (3) the Cuddapahs and Delhis, (4) the typically iron-ore-bearing schistose Dharwars, and (5) the hypo-metamorphic Charnockitic Province of rocks around the supposed oldest Bundelkhand granite is a noteworthy feature of the pre-Cambrian shield of Peninsular India. A comparison of their structural, lithologic and metamorphic characteristics suggests that the Charnockitic Province occurring in the extreme south and east of the Peninsula may be the oldest of the Peninsular Archaeans. The Manganese ore—Marble Province, viz., the belt of Aravalli, Sausar, Gangpur and North Singhbhum Iron-ore Series, would be the next younger group, followed by the typically iron-ore-bearing schistose Dharwars. The unmetamorphosed Cuddapahs and finally the Vindhyans are known to be the youngest of all. The schistose Dharwars are folded about a roughly North-South axis and reveal a single stage of folding, igneous intrusion and metamorphism. The Charnockitic and Manganese ore-Marble Provinces show at least two stages of folding, igneous intrusion and metamorphism, the second stage cross-folded axial trend being roughly parallel to the Dharwar axis.

On modern concepts, these correspond to succeeding periods of geosynclinal sedimentation and orogeny. The massive granitoid gneisses which make up a greater part of the Peninsula and the Bundelkhand granite may be the oldest cratons or nucleii around which these episodes have taken place and the evolution of the pre-Cambrian shield has been accomplished. In general, the pre-Cambrian shield seems to have evolved from south to north, and post-Cambrian evolution has taken place mainly to the north, moulded over the rigid pre-Cambrian shield.

The remarkable resemblance of structural patterns, periods of folding, and metamorphic grades in the Charnockitic and non-Charnockitic Provinces in India, South Africa and West Australia suggests a common mode of geosynclinal sedimentation and orogeny in such distant continents. It seems most probable that "Gondwana Land" was evolved as early as the pre-Cambrian time, but how this land was disrupted is problematical.

3. DR. F. AHMAD (Geological Survey of India): *On various concepts about the Origin of Continents.*

The author examines the various theories on the origin of continents and points out that on the basis of a contracting earth with fixed continents, it appears difficult to explain the Tertiary orogeny, the Upper Palaeozoic glaciation, and the distribution of certain important rocks, minerals and fossils, while the drift hypothesis explains these far more satisfactorily. Even though the mechanism of the movement has not been worked out, there appears to be a strong *prima facie* case for Wegener's theory.

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* The work was carried out in the Geology Dept., University of Tasmania under the Colombo Plan Senior Fellowship.

He criticises Rode's sheet movement concept both on the basis of facts and fundamentals of geology. It is thus pointed out that the various sections quoted by him are wrong, and the entire concept is impossible.

He then examines the various reconstructions of Gondwanaland, and points out that none so far offered appears to meet the demands perfectly, but the one proposal by S. W. Carey may be the nearest approach to the original land form. Fewer attempts have, on the other hand, been made to reconstruct the northern continent, and it has, therefore, been left out of argument. If a drift of the Gondwanaland can be proved, further arguments are not necessary to prove a drift of Laurasia.

4. Sri A. K. BANERJI (Calcutta) : *Evolution of Continents by Geosynclinal Deformation.*

A study of the geology of the continents indicates that they consist essentially of two types of structural units—the apparently immobile and stable continental shields and the mobile and unstable Orogenic belts. According to Lees (1953), the earth's crust has suffered a total compression of about 3000 km. in its orogenic belts in the three pre-Cambrian and another three post-Cambrian orogenic phases. Reasons are given to show that Lees' theory does not hold good. On similar and other grounds, Wegener's theory for continental drift and the theory of compression in the orogenic belts due to shrinkage of the earth's crust by 'heat loss' may also be rejected. Probably, the hypothesis of geosynclinal deformation by convection currents, (as shown by Vening Meinsez-Griggs-Hess-DeLury) may explain well all the features of the orogens such as, mountain-building, magmation and metamorphism. The author successfully applied DeLury's hypothesis to correlate metamorphic episodes to magmatic-orogenic events in South Knapdale, Scotland. The geosynclines are thus the clue to the story of the evolution of continents.

XIV. NATURAL REGIONS OF INDIA.

1. Prof. MANORANJAN CHAUDHURI (Calcutta) : *Natural Regions of India.*

Much of confusion hitherto exists about the term "Natural region". Very often the terms "Natural region" and "Geographic regions" are used almost in a synonymous sense. In modern geographic literature both the terms must be distinguished. The border line between "Geographic regions" and "Natural regions" is not difficult to see. The geographic region is the unit area formed by aboriginal condition, geological structure, and rock pattern, reformed and partly redefined by man. An area of earth's surface, essentially homogeneous with respect to conditions that effect human life may be termed a "Natural region", as Herbertson had put it. Thus two "Natural regions" are essentially alike with respect to conditions that effect human life. But each geographic region is distinct from the other. In a "Natural region" one can expect a number of "Geographic regions". "Geographic regions" of India in place of "Natural regions" would be a more scientific expression. The author for instance would refer to the geographic regions of India envisaged by him. About the nomenclature of the regions, no hard and fast formula can be given. This would require imaginative audacity. Sometimes, physiography would dominate the regional life. The economic conditions would sometimes dominate it. The nomenclature would also be accordingly made. The geographers must be addressed to the great task of defining the regions.

Section of Botany.

XV. EFFECT OF GROWTH PROMOTING SUBSTANCES ON CROP PRODUCTION

Chairman : DR. J. C. SEN GUPTA (Calcutta).

1. PROF. P. K. SEN (Calcutta) opened the discussion :

The discovery of hormones in plants and inventions of chemicals having the properties of phyto-hormones have brought an unprecedented revolution in crop production in that with the application of such substances man can now control growth pattern of plants, stimulating here and retarding there, at will. Within hardly 20 years such chemicals, commonly known as growth-promoting or growth-controlling substances, have come into common practice in many spheres of agriculture, especially in horticulture, and the prospect of their use in field crops are also increasing as researches are advancing. India's contribution to such researches is also not insignificant.

In horticulture the use of growth substances have almost become a routine matter in respect of promoting rooting of cuttings and layerings. They have also been found useful in blossom thinning for controlling crop size and correcting alternate bearing, for preventing pre-harvest drops and as aids to fruit-set and production of seedless fruits.

As weed killers such substances have come into wide application in field cultivation, and researches are in progress indicating the prospect of growth substances as useful pre-sowing treatments, and for breaking or prolonging or inducing dormancy, and so on. We may hope, with confidence that in no remote future it will be possible for us, if we pursue research in right earnest, to adjust growth of crops to our climates and conditions, as they prevail, to give the best of harvests, in quality and quantity.

2. PROF. L. S. S. KUMAR (Poona) :

The remarks I shall make are entirely confined to the application of growth regulating substances to improve agricultural crops. Growth regulators used were 2, 4-D, I.A.A., N.A.A. Amongst the substances used 2, 4-D has given very promising results with seeds of wheat, javar, groundnut and rice. When treated in low concentration from 1 to 100 p.p.m. the herbicide has had a stimulate effect and has resulted in increased yield. It has been observed that response to treatment raises with the variety, soil, character, season, agronomic practice etc. It would thus indicate that it would be necessary to arrive at the exact treatment by taking into consideration the responses to the foregoing factors.

Use of growth regulators has resulted in increase in sugar content of sugarcane. The increase is of temporary duration and for higher recovery of sugar the cane has to be harvested and crushed during this temporary stimulated stage.

By use of 2, 4-D., it has been possible to control excessive vegetative growth in rice which goes under the name of "Running to leaf". The treatment restores seed-setting from 60 to 80% compared to the setting in the normal.

Use of growth regulators has been successful in inducting earliness of flowering and fruit development in pineapple and shedding of fruits in mango.

3. Sri S. P. SEN (Calcutta) : *Mechanism of Auxin Action in Relation to Growth and Development.*

How auxins may affect crop-production can be understood from a consideration of the physical and chemical basis of the mechanism of auxin action in relation to growth and development. Earlier literature is reviewed and emphasis is laid on the recent observation that growth promotion by auxins can be interpreted in terms of enzyme kinetics. The affinity of the auxins for enzymatic receptor sites within the plant and the growth response exhibited when all the receptor sites are filled with the auxin molecules concerned, are controlling factors in the growth reaction. These values can be determined and have been found to be different for different auxins. Slight changes in the structural configurations of an auxin molecule may convert it to an anti-auxin as structural requirements for auxin action in such a case may not be fulfilled.

Chemical and biological evidences are advanced in support of the contention that the COOH group in the acetic acid side chain of auxins reacts with the—SH group of Coenzyme A giving rise to a thiol ester which constitutes a high energy bond. This reaction requires an enzyme (which can be isolated from the mitochondria of a large number of plant tissues) and adenosine triphosphate but no pyridine nucleotides. Compounds resembling auxins in structural configurations but possessing no auxin-activity do not participate in such reactions. The implications of this reaction in relation to metabolic pathways controlling growth and developmental phenomena and herbicidal properties of certain auxins are discussed.

4. Mr. R. N. CHOPRA (Delhi) :

Work has been done on eleven plants for producing parthenocarpic fruits by artificial means : Six members of the Cucurbitaceae, (*Luffa acutangula, Lagenaria vulgaris, Trichosanthes anguina, Coccinia indica, Momordica charancia* and *Cucumis sativus*) ; two of the Solanaceae, (*Datura fastuosa* and *Nicotiana rustica*) ; two of the Papaveraceae (*Papaver somniferum* and *P. rhoeas*) and one of the Caricaceae (*Carica papaya*). Mainly two hormones, N.A.A. and I.B.A. were used both as pastes and injections, the range of concentration being from 0·05% to 2·0% in paste and from 0·1% to 0·3% in aqueous injections.

A good response was given both as regards the number and size of the parthenocarpic fruits in *Luffa, Carica, Papaver* and *Datura*. Seed development was also noticed in Carica, Papaver and Datura but these represented nothing but empty seed coats, except in the case of Datura in which a tumoral outgrowth was observed inside the ovules. Such an outgrowth has also been reported by Van Overbeek *et al* (1941) in *D. stramomium*, and by Sattina *et al* in certain incompatible crosses in Datura, and has been designated as "pseudoembryo" by the former authors.

5. Dr. S. K. MUKHERJEE (Krishnagar) : *Effect of hormones in rooting of fruit plants.*

Fruit trees are generally propagated by vegetative methods to maintain the superior quality of fruits of the selected plants The common processes employed are grafting, budding, cutting and air layering. The last two methods require induction of root formation from the stem. Some plants root easily e.g. mulberry, citrus. litchi etc., whereas others do not easily give out roots by the common methods employed e.g., mango, jack-fruit etc. Since the discovery of the effect of hormones in promoting root development, a large number of chemical substances have been tried on various plants. Some trials on the effect of hormone in rooting of air layers of mango (*Mangifera indica L.*) jack-fruit (*Artocarpus heterophyllus Lam.*) and rose apple (*Syzygium jambos*) have been undertaken at the horticultural research station, West Bengal, Krishnagar.

Twentyfive shoots (2 years old) of each type were treated with Seradix B 3 (May and Baker) and 25 kept as control. About 1½" wide rings of bark were removed from the selected twigs, about 18" below the tip, and the exposed portion dusted with Seradix powder. After removing the excess powder, it was covered with moist sphagnum and wrapped with alkathene (I.C.I.), two ends of which were tied tightly with twine. This was repeated every month from April to September. When the air layers gave out roots they were lowered from the plant and potted.

The results show that jackfruits respond favourably to the treatment. In the control four have rooted none of which survived after potting but sixty have rooted among the treated ones, thirtyone of which survived after potting. Maximum amount of root development taking place during the months of July to September. In roseapple, maximum rooting took place during the month of April, and difference from the control lay mainly in the quickening of the process of root formation. In the control, it took about 9 to 10 months to produce roots whereas in the treated plants it took 2½ to 3 months. Mangoes have not responded so well to the treatment. There was no rooting in the control. Only 25 among 50 treated plants produced roots out of which only 11 survived after potting.

The present observation is of special practical importance in the case of jackfruit and in the roseapples. Jackfruit is one of the important fruits in West Bengal and Malabar where it occupies a major area. It is a good fruit and can also be used as vegetable. The present practice is to raise the plants from seeds, which does not allow maintaining uniformity in the quality of fruits. The seedling plants also take a long time to bear fruits. The success of the present method opens up a very promising line for the propagation of jackfruit and in its widescale application for propagation of jackfruit. The method is quite easy to handle even by common growers as a nursery practice and will not entail much cost. Vegetative propagation of jackfruit will also ensure maintaining uniformity of characters of the clonal selections.

Propagation of roseapple is likely to be done within one season by the present method, which will be also of practical importance. Mango propagation by gooties may not be practiced widely in preference to the present method of inarching, but the present method will be of importance in raising of uniform stocks and their standardisation.

6. Dr. S. M. SIRCAR (Calcutta) : *Growth Hormones in Rice Plant.*

Growth hormones in rice plant are being studied in this laboratory in order to understand the onset of flowering. Methods of assay of hormone content in rice plant have been standardized. Preliminary work indicates that rice endosperm contains large quantity of hormone which disappears during germination at the room temperature. Low temperature vernalization results high auxin content in the endosperm whose action is manifested in the early growth phase-tillering, but no acceleration of flowering. Relation of the auxin content in the different fractions of the endosperm with the growth of the seedling and the effects of the application of hormones on the growth of the isolated embryo have been studied.

Application of Indoleacetic acid and Naphthalenacetic acid at a later stage of the plant by spraying has resulted early ear emergence, the effect being noticed at the initiation of floral meristem.

7. Sri SALIL KUMAR CHATTOPADHAYA (Darjeeling) : *Effect of hormones on fruit-set and seedlessness.*

Pollination of the flower is essential to the formation of fruits of most kinds of plants. The development of fruits without seeds from unpollinated flowers, while a comparatively rare occurrence, is nevertheless familiar. In natural parthenocarpy pollination either does not take place or is ineffective in bringing about fertilisation and seed development. Gustafson (1936) first applied specific chemicals of the nature of hormone and obtained mature seedless fruits with pollination. Today hormone-induced parthenocarpy and seedlessness of different fruits have attracted a number of modern workers, who are engaged in finding out greater details of the problem.

Analysis of the results obtained by different workers in India shows that tomato plants (*Lycopersicum esculentum* L.) more or less respond favourably to hormone treatments. Thus in tomatoes, an increased yield was noted by Randhawa & Thompson (1949) and by Randhawa (1950-51), while marked seedlessness was noted by Venkataratnam (1950) and by Singh & Kacker (1952), by treatments with hormones. The experience of the present author (1954) shows that of the three hormones tried (IBA, IAA & NAA), IBA caused a greater percentage of fruit-set in comparatively lower concentrations when applied on three consecutive days. The same hormone induced seedlessness in higher concentrations markedly. Of other fruits, *Hibiscus esculentus* L showed pronounced seedlessness with IBA at anthesis treatments, *Citrullus vulgaris* Schrad exhibited the same effect with NAA at post-anthesis treatments and Cucurbita pepo DC failed completely to all the treatments. In addition, post-anthesis treatments with *Hibiscus esculentus* L produced larger sized fruits.

It is worth while to mention the physiological basis of hormone-induced fruit-set. Gustafson's (1942) view of normal development of fruit is that growth of the ovary following fertilization is brought about by auxin introduced in the pollen, whereas naturally parthenocarpic fruits are produced through the influence of auxin present in larger quantity in the ovary than occurs in those varieties which require fertilization for fruit development. In addition, it may be stated that where this natural supply of auxin is inadequate, it may be corrected by the application of synthetic hormones, which induce changes in the ovary duplicating those normally brought about by pollination The result is the development of seedless fruits artificially. And lastly, the treatments at post-anthesis stage of flowers led to the accumulation of larger dosage of mixed hormones : from pollen as well as of specific chemical hormones used in the treatment. These caused increased cell-expansion in developing fruits leading to their bigger sizes.

8. Dr. R. D. ASANA (New Delhi) (In Absentia) : *Influence of Plant Hormones on the Growth of Wheat.*

As a result of experiments, conducted during the last five years, it has been found that application of beta-indoleacetic acid and alpha-naphthaleneacetic acid (infiltrating through cut leaf-tips or as spray) significantly increased the grain yield of wheat raised under pot-culture. The increase in yield was brought about as a result of increase in one or the other ear character. A similar favourable effect was also obtained in one season under field conditions. It appears necessary to determine the causes underlying the inconsistency of the effects of the growth substances on the various characters.

It is suggested that while auxins cannot as yet be applied directly for increasing crop production, research on the fundamental aspects of the problem would be worthwhile.

9. Dr. S. KRISHNAMURTHI and Sri D. SUBRAMANIAN (Annamalainagar) (In Absentia) : *The Use of Growth Promoting Substances in Vegetable Production.*

Much has been accomplished in improvement of vegetables by the application of growth promoting substances by increasing fruit-set, size and yields, besides inducing parthenocarpy and improving quality of fruits. Among the growth regulators used, substances from the group of substituted phenoxy, naphthoxy, naphthalene and indole compounds have been important. The results achieved in tomato, bean, brinjal, pepper, cucumber, pumpkin and water melon, are summarised below:

Tomato has received most of the attention. In the green house studies, the fruit-set in tomatoes has been increased by application of certain growth regulators and such applications supplement pollination which is poor under conditions of low light and low temperature at the time of flowering. The total yield is increased due to the effectiveness of 'hormones' in making the blossoms set fruit and in preventing abscission of flower-buds and fruits. Early yields obtained by various 'hormone' treatments coupled with an increase in the average weight per fruit fetch better prices in the market. The use of growth substances in the tomatoes for improving yields and fruit-set on a field scale has resulted in somewhat contradictory data. The use of whole plant sprays as compared with flower cluster sprays has at times reduced the set of fruit probably because of the inhibitory effect of growth substances upon the young flower buds. Studies carried out in other countries reveal that 2, 4-D (2 to 5 ppm), p-CLPA and L-(p-CLP) propionic acid (25 ppm), 1-naphthoxyacetic acid (25 to 50 ppm) have been effective for increasing yield and hastening maturity in tomatoes. Studies conducted at Annamalai University on tomatoes with Ammonium salt of 2, 4-D increased fruit-set by 189 per cent over the non-treated.

In Brinjal, at the Annamalai University, interesting results in inducing parthenocarpy and early maturity and increasing fruit-set and yields have been obtained in small scale trials with the use of 2, 4-D, B-Naphthoxy acetic acid and L-Naphthelene acetic acid. Application of certain growth regulators like B-Naphthoxy acetic acid and naphthalene acetic acid has resulted in increasing crop yield in snap beans. In pepper, successful results of parthenocarpy have been reported with the help of growth regulators; but attempts have been too few regarding fruit-set and yields. In cucumber, indole acetic acid, naphthalene acetic acid and chlorophenoxy acetic acid have been among the substances used for this purpose with some success. In pumpkin, success in inducing parthenocarpy with the use of plant growth regulators has varied according to the varieties. In general, naphthalene acetic acid appears to have been more useful in inducing parthenocarpy and increasing fruit-set. Among other substances tried and found fairly successful were indole butyric acid, 4-fluorene acetic acid, pyrrole-α-carboxylic acid and pyrrole-α-acetic acid. In water melons, for inducing parthenocarpy, generally, a mixture of chemicals has been somewhat more effective than single substances, and in such mixtures, naphthalene acetic acid as a component has been comparatively more successful.

Studies made on the composition and nutritive value of 'hormone' treated fruits compared to non-treated fruits of tomato have shown somewhat varying results, but in many cases increase in total sugar content has been reported.

It can be generally concluded that immediate causal factor in fruit setting is 'hormonal', provided nutrition is adequate. The most profound influence on the yield and fruit-set of crops reported as responding to the application of growth substances is obtained, when the prevailing environment is not conducive to normal fruit-set. So far, most work has been done on tomatoes. The opportunities for the improvement of other vegetables with growth-regulators are unlimited, provided the proper techniques are developed to utilise such resources.

10. Sri K. KUMAR, Sri K. L. MUKHERJEE and Sri R. SINGH (Banaras) (In Absentia): *Effect of I.A.A. and P.A.A. on the growth and yield of Tomato and Onion.*

Tomato and onion were grown in sand with Hoagland's nutrient solution (complete, -N, -P, -K) and in well-manured soil. I.A.A. (indole-3-acetic acid) at

0·15—1·00 ppm. concs. and P.A.A. (Phenoxy acetic acid) at 0·008—0·80 ppm. concs. were applied as growth substances to sand pots and at 0·1 ppm. (I.A.A.) to soil pots.

Growth character study reveals that I.A.A. at concs. 0·15—0·30 ppm. and P.A.A. 0·008—0·08 ppm. were either slightly stimulative or ineffective in producing better growth, while higher concs. were toxic. -N, -P, -K when supplemented with hormone (I.A.A.), -K was found to be effectively replaced by hormone, -P partially, while it was of no use for -N. Application to soil brought significant increase in growth. Reasons tendered are that plants grown under optimum environmental conditions are not deficient in growth substances. Additional application is either a luxury consumption or proves toxic. Stimulative effect in soil culture may be attributed to its effect on the complex micro-flora of soil rather than to the growth substance directly. Increased growth in potassium deficient plants by hormone treatment shows that potassium deficiency may possibly be associated with decreased hormone content. In other cases (-N, -P) the nutritional factor itself may be the reason for decreased growth.

11. Sri B. SEN (Almora) (In Absentia) :

It has now been well established[1, 4] that plant growth substances have regulating influence in all phases of plant life—germination of seed and sprouting of tubers, elongation and differentiation of cells, formation of roots and shoots, floral initiation, fruit set, fruit growth and fruit drop. The discovery, identification and synthetic production of many plant growth substances have raised great hope for a spectacular improvement in crop production. Except for controlled initiation of flowering in pineapple, however, no outstanding results with other crops have yet been reported, though spraying of growth substances for control of fruit set and fruit drop has now become a standard practice in progressive apple and pear orchards. Where agricultural industry is mechanised, indirect contribution to crop production by the use of growth substances which form the basis of modern selective herbicides such as 2, 4-D, methoxone, 24, 5-T has been substantial.

It is only in micro and sub-micro concentrations of growth substances that stimulating effects are induced in plant organs, and it has been found that in certain cases the regulatory stimulating effect of growth substances can be duplicated or bettered by the use of micro-elements. For instance, the germination and length of pollen tubes (which are important factors in effective fertilization) are stimulated in Madonna Lily by micro and sub-micro concentrations of most of the growth substances, but greater stimulating effect can be induced by micro-concentration of boron in the germinating medium.[2] Again, shortening of the vegetative phase, as also of the node number at which flowers emerge, of Mustard T. 102 can be induced by soaking the seeds in micro-concentrations of growth substances, but greater shortening of the vegetative phase without any shortening of the node number can be induced by soaking seeds in micro-concentrations of boron or manganese.[3] Since growth substances have stimulating effect in micro and sub-micro concentrations but are toxic at higher concentrations, it is essential to determine the optimum concentration of growth substances in different plant organs and their supply-potential at different stages of development. Until we have such knowledge, agriculturists and horticulturists are not likely to derive the benefit of controlled crop production which the proper utilisation of growth substances should make possible.

12. Dr. R. S. CHOUDHRI and Sri R. RAJAGOPAL (Banaras) (In Absentia) :

Study of the naturally occurring auxins and chemically synthesised, physiologically active growth regulating substances reveals that the growth behaviour of plants can be effectively controlled to fit into our needs. Variously called, these hormones profoundly influence plant growth in minute concentrations by inducing morphological, histological and physiological changes, even in organs far away from the site of application. Used as acids, esters, amides and salts, one being preferred over the other depending upon their solubility, volatility and availability. Spraying, dusting, soil treatment, exposure to vapours, dipping in solution and lanolin paste application, are the chief methods of application in vogue, the duration of treatment depending upon the nature of the plant and the intrinsic property of the chemical used. Caution is to be observed in using these, as higher concentration and duration or improper time of application, may result in retardation or inhibition of crop growth. Higher percentage and speed of germination, initiation of good rooting, increased tillering, earlier blossoming, prevention of blossom and fruit-drop, prevention of premature bolting, induction of parthenocarpy, better fruit-set coupled with good quality, resistance to some diseases, and higher yield are some of the significant results recorded and reported in a variety of crop plants. Help crop production indirectly by their selective herbicidal action without detriment to the crop plant. "Without hormone, no growth."

13. Dr. R. S. CHOUDHRI (Banaras) (In Absentia) : *Studies of the effects of certain plant hormones on growth, general behaviour and food transport of Phaseolus Vulgaris L.*

These extensive investigations were carried out at the New York State College of Agriculture, Cornell University, U.S.A., by the author during the years 1946 and 1947, black wax bean (*Phaseolus vulgaris L.*) being used as a test plant. Several plant hormones representing different groups and their derivative salts were used in different concentrations to treat the different parts of the plant. The susceptibility of different plant parts or organs depended upon the structure and the age of the constituting tissues. Following treatment of one part or the other, the noteworthy features were, the movements of the growth substance and of the plant food respectively. Whereas the former, specially the phenoxy compounds, could move to long distances from the site of application, the food migration was contrariwise greatly inhibited depending upon the dosage administered, and if at all, it moved to the treated site from regions remote. This was obvious by the increased weight of treated parts and by the characteristic thickenings observed at site and in the vicinity of the treated region. Such treatments delayed the usual abscissions of plant organs (such as those of cotyledons, leaves, buds, flowers, fruits etc.), limited the growth of parts located distantly from the venue of hormone application, stimulated axillary growths, induced many different types of formative effects and initiated seedlessness in fruit pods. All such effects seemingly resulted from a tendency of these hormonal substances to prevent or at least to inhibit the migration of food from the seat of hormone application. Mere treatment of leaves (which form the main source of food supply) resulted in a set back of root growth and even in the nodulation tendencies, evidently due to lack of carbohydrate supply. Only lighter dosages supplied to seeds in the form of pre-sowing treatments, could stimulate germination of seeds.

In view of the marked effectiveness of these wonder chemicals of hormonal nature on food movement in plants, the choice and dosage of treatment has had to be highly judicious and the purpose of using them had to be kept in forefront viz., whether it is intended to improve seed germination, to stop leaf-fall, to induce early blossoms, to prevent fruit drop or to initiate seedlessness.

11. Dr. S. C. CHAKRAVARTI (Bhopal) :

It has not yet been conclusively proved that the application of growth promoting substances can increase yield of crops directly. Nagato and Sato of the Nagoya University, Japan, recorded better fruiting in paddy with pre-transplanting hormone-treated seedlings, only when the plants experienced an adverse environment in the latter period of growth. Experiments in India along similar lines might prove to be fruitful.

With the exception of pine-apple, almost all the experiments where an early flowering has been induced through the application of hormones, are confined to non-crop plants. Chakravarti and Pillai have, however, been recently successful in inducing early flowering in mustard through spraying treatment of seedlings Observation of Leopold on an increase in the number of floral primordia in Wintex barley by an application of IAA or NAA is worth giving trial with other cereals crops in this country.

Vernalization induces early flowering in a few crop plants and that too is accompanied with a decrease in yield. Recent work of Leopold and Guernsey on "chemical vernalization", in inducing earliness in flowering in several non-vernalizable crop plants and of Chakravarti and Pillai in the induction of an additional earliness in flowering in mustard over that obtained by vernalization alone, through a pre-chilling-hormone-treatment, are of interest.

Suitable trials should be undertaken to evaluate the possibility of "chemical vernalization" on crop production.

Dr. R. N. SINGH (Banaras) and Dr. B. SAMANTARAI (Cuttack) also participated in the discussion. Prof P. K. SEN wound up the discussion in the end. The Chairman summarised the contributions of the various participants. He pointed out that, while some practical results have been achieved, elucidation of the mechanism of the action of the growth hormones has not been explained adequately from the fundamental point of view and hoped that it will receive the attention of the workers in the field.

XVI. APPLIED ECOLOGY.

Chairman : Dr. J. C. Sen Gupta (Calcutta).

1. Sri K. L. AGGARWAL (Dehra Dun) opened the discussion.

He said that the study of the subject of Applied Ecology came into prominence only recently to meet with the shortage of food, fodder and fuel after the Second World War. He pointed out the necessity to bear in mind the two basic concepts of Ecology namely, (*i*) Plant succession and Climax and (*ii*) Plant Indicators while studying Applied Ecology problems in Forestry, Agriculture, Soil Conservation, Preventing erosion, Flood Control, Fish Culture etc., and illustrated as to how these two concepts help us in the study of Applied Ecology in the above mentioned fields. He also pointed out the desirability of fundamental studies in Ecology which would ultimately aid in the solution of problems of the applied aspects.

2. Sri S. K. SETH (Naini Tal) : *Applied Ecology in Forestry.*

In the field of forestry, ecology has its principal application in the techniques of silviculture. These may be broadly classified into four sections according to the ecological approach involved :

(*i*) Silvicultural systems with natural regeneration.
(*ii*) Silvicultural systems with artificial regeneration.
(*iii*) Subsidiary silvicultural operations.
(*iv*) Introduction of exotics.

The first desideratum is a practical classification of forest types. It is in this perspective that the above four categories should be considered. Under the first category are included the standard techniques of natural regeneration which are examples of applied ecology restr cted and conditioned by management patterns.

The second section deals with artificial propagation of plants and illustrates the application of fundamental ecological principles although on a restricted scale. The third section embodies somewhat localised practices which find their main application inside the broad framework of silvicultural systems but are more purely ecological in nature. The last category treats of an aspect of forestry in which the correct evaluation of complex ecological factors should precede experimentation and where eventual success may depend upon the nicety with which ponderable and imponderable factors were assessed. Examples are sited and discussed.

3. Dr. R. MISRA (Saugar) : *Some Plant Indicators of Sagar (M.P.).*

(a) *Physiographic Indicators.*

Carissa spinarum is an indicator of intensive erosion on hill slopes of tap areas. The plant propagates rapidly from the exposed root suckers. *Capparis sepiaria* with a similar habit is found to colonise bad lands of the upper gangetic plain. *Zizyphus rotundifolia* on the otherhand thrives on foot of hills and such areas which receive deposits from higher lands. It grows in circular patches and the covered stem assumes a rhizomatous character with sprouting shoots. Thus these species can be used in the indicated situations for rapid reclamation.

(b) *Indicators of Soil Conditions.*

Cassia tora and *C. obtusifolia* indicate recently disturbed soil. They grow on excavated and deposited soils, along drains, streams, roads and mango groves. Thus soil aeration is indicated.

Enicostema littorale grows on well drained soil in meadows. According to increasing duration of waterlogging *Cyperus* spp., *Ischaemum rugosum*, *Saccharum spontaneum*, *Chrozophora rottleri*, *Heliotropium supinum*, *Polygonum plebejum*, etc., grow respectively in depressions. The seeds in these cases rot in water before germinating. Thus these plants indicate drainage conditions.

Spermacoce stricta populations correspond with the iron content of the soil. *Woodfordia floribunda* on eroded soils and *Choris virgata* on stabilised soils indicate lime content. *Lippa nodiflora* and *Rumex* spp. indicate nitrate content. Thus these are chemical indicators.

(c) *Indicators of Grazing.*

As the intensity of grazing increases the followilng species occur in the grasslands in order of range deterioration—*Themeda caudata*, *Iscilema anthephorides*, *Schima narvosum*, *Dichanthium* spp., *Bothriochloa pertusa*, *Sporobolus diandar*, *Eragrostis* spp., *Urochloa reptans*, *Indigofera ennaephylla*, *Manisuris gracilis*, *Eleusine aegyptiacum*, *Indigofera cordifolia*, *Melanocenchrus cenchroides*, *etc.*

(d) *Aquatic Plant Indicators.*

Utricularia spp., *Ottellia alismoides*, *Chara* spp., *Spirodella* ~~sp.~~, *Wolifia* sp., and myxophyceae indicate polluted water. *Limnanthemum* spp., *Nelumbium speciosum* and *Potamogeton* spp., indicate rapid silting. *Potemogeton crispus*, *Hydrilla verticillata* and *Cerotophyllum demersum* indicate hard water.

It is suggested that plant indicators are useful in afforestation schemes and designing management of land and water.

4. Dr. C. B. RAO (Rajahmundry) : *Small Sheets of Water, their Algal content and Fish Culture.*

Small sheets of water, though situated in the same neighbourhood and on the same geological substratum and appearing apparently identical in character, harbour varying algal flora, the flora being widely different and characteristic of each. These variations may be attributed to the variations in the chemical composition of the water in each case. For studying the influence of the chemical factors on the algal flora, smaller sheets of water are more suited than larger ones because the former react to changes in the environment more quickly than the latter.

Observations on a few small sheets of water in a temperate zone have indicated that flagellates are more numerous in acidic ponds than in alkaline ones. Among acidic sheets again, those with a higher C/N ratio and a higher concentration of total iron harbour a higher percentage of Euglenineae. Green algae (Volvocales, Chlorococcales and Desmids) were poorly represented in sheets of water with a high concentration of albuminoid ammonia and a low quantity of oxygen. Diatoms were in larger numbers in alkaline ponds than in acidic ones. The alkaline waters also showed higher bicarbonate content and more total dissolved solids than the acidic ones. Blue green algae were plentiful in waters having high organic matter and low O_2 concentrations, besides pH around neutrality.

Distinctly acidic sheets of water and distinctly alkaline sheets of water harbour richer floras, though widely different in nature, than water sheets around neutrality. The algal flora of any sheet of water could roughly be a pH indicator.

Sheets of water observed in South India confirm the findings given above regarding green algae and blue-green algae. Flagellates, however, are to be associated with waters around neutrality and usually having higher C/N ratio. Distinctly acidic tropical sheets of water are not come across by the writer and therefore not studied. Waters with lesser concentration of oxygen and a rich iron content show larger numbers of Euglenineae. Higher C/N ratio and a maximum algal population show a correlation.

By making use of knowledge regarding food chains of fish noted for fish-culture, one could readily associate a particular fish group with a particular sheet of water and obtain desirable results in fish-culture.

5. DR. R. N. SINGH (Benares) :

Pointed out the application of Micro-organisms in the field of Ecology and felt that reclamation of usar soils may be helped by studies on Blue green problems in India. He also suggested that it may be possible to replace *Chlorella* by *Anabaena* while dealing with unconventional food production.

6. PROF W. H. PEARSELL (London) :

Participated and dealt with sets of problems in Applied Ecology. The problems of Applied Ecology include those of water, swamp and terrestrial soils of which examples have already been given. He pointed out the possibility of improving soil conditions by using appropriate ecological methods. As an illustration an example was given of experiments designed to improve run down soils, depleted either by bad land area, by climatic deterioration or by uncontrollable silvicultural-treatment. These experiments have been set up by the National Conservatory in Britain. They consists of plots on run down soils each containing a single tree species of plants which are believed to alter the character of the soil by controlling leafy and other detracts to the surface. Some are believed to raise the Nitrogen status and other the status in certain mineral materials such as Calcium and Potassium.

7. PROF. SUKACHEV (U.S.S.R.) :

To my mind Mr. Ranganathan was quite right when, in his address he said that silviculture is Applied Ecology. This was once more shown in the reports of Dr. Aggarwal and others. I may go further and even say that agriculture and forestry, if we understand these words in wide sense, are Applied plant Ecology, including into it Phytosociology.

This, to my great regret is not sufficiently recognised. In particular not enough attention is paid to the training in these branches of Botany in the Agricultural Colleges. In the universities of U.S.S.R. special geo-botanical laboratories can be found, where students are trained in Ecology, Phytocenology and Plant Geography. Phytocenology in the U.S.S.R. is widely used in Forestry in the growing of grass and when cultivating the fodder plant. In the main questions which arise in the mixed strands of trees and grasses—are the forms of combinations of plants and their density and these are of phytocenological significance and with the help of its datas, the questions are solved. Now in plant Ecology and Phytocenology the following problems stand before us—

(*a*) To make a survey and to put into order all the extensive data already published in big number of books on Autoecology and Phytocenology, but this is not enough. These data must have such an interpretation so as to be of direct use for the grass and forest growing. This is a big task and I would say not an easy one. It could be done only by scientific workers who are equally well informed as in theoretical questions of Ecology, as well as in different branches of Forestry and Agriculture.

(*b*) As in forestry and Agriculture the stands of crops usually are created more or less dense, so along the investigating the relation of plants to the factors of the environment. (Climate, Soil fauna). It is necessary to do more research experimental work to study the coaction of plants, in the case when a number of plants grow side by side. This coaction may be of good or bad character. In other words the movements which are included in Darwin's 'Struggle for Life' be studied. Experimentally this has not been largely investigated but for applied Phytocenology it is of the utmost importance.

(*c*) Special Eclogo—Phytocenological stations or, to say more accurately, biogeocenological stations in definite plant associations in nature itself should be organised. These stations should be of complex character where the vegetation (from the ecologo-physiological point of view) is studied along with all other factors of the medium and with the relations to the vegetation. It is of special importance that in these stations works of experimental character should be conducted in a wide scale i.e. they must lead to the development of experimental Phytocenology.

(*d*) The teaching of the Ecology and Phytocenology in Colleges and Universities should go on in a more wide scale.

8. PROF. MOLTCHANOV (U.S.S.R.):

Besides the description method of investigating the Ecology of trees and their communities in our country much attention is paid to these factors of the medium which influence the germination of seeds, growth and development of plants. When investigating these ecological characteristics of plant growth the microclimate and the water regime of the soil are studied in detail. In other words the bioclimatic conditions of different forest and agricultural crops are cleared out. In this case special attention is paid to the reaction in the growth and development of plants on the changes of temperatures, humidity of the air, light conditions, humidity of the soil and its general fertility. It is already a long time that in the U.S.S.R. the meteorological determinations are made as under the canopy of the trees, in different types of forests and also on open spaces covered with grasses or agricultural crops. Along with the investigations of the bioclimate of the forests much consideration is also given to the microclimatic conditions of the fields adjoining to the forests and also of the shelter beds and the areas between them.

The microclimate is investigated with the help of specially set up meteorological stations. At these stations the units are fixed on the surface of the earth, five centimeters above it, just over the grass cover and 200 centimeter above the crowns of the trees. At the same places the humidity of the soil upto 360 centimeters is determined with help of evaporators the evaporation from the surface of the vegetable cover, soil surface and the transpiration of this cover are also determined. The light conditions are cleared up and the different stages of plant development and specially the increase in height and diameter are determined.

As to the grass cover, the phases of its development are fixed, its mass in weight units and increase in height are determined. The forest bioclimatic stations are set up in the more widely distributed types of forests, in the trees-stands consisting of different species and also in forest of various age and density.

The fields covered with various crops the stations are set up at different distances from the forests or shelter-belt.

The following distances from the shelter-belt or forest in meters can be proposed 10, 50, 100, and 250. On the basis of the data obtained, the relationship of growth and development of plants according to the temperature, humidity of the air and soil, precipitation, light conditions and evaporation are determined. As experiment has shown the bioclimatic investigation of this kind are helpful in establishing the methods of degeneration and conditions of growth of coppies after selection, cutting and thinnings. They also help to find out the productivity of the stand as a result of changes which take place in the factors of the medium when different thinnings are conducted. It is possible to determine the width of clear-feelings which will be optimal for the growth and regeneration of coppies, the direction of these feelings according to the compass, and also to find out the distance between the shelter-belts, which will be optimal for the growth of agricultural crops.

9. **DR. G. S. PURI** (Dehra Dun) :

Mr. K. L. Aggarwal in his stimulating opening address has broadly indicated the numerous fields of human endeavour in which plant ecology has been used or has future possibilities of service. Other speakers have indicated other fields in which ecological techniques find application.

I shall confine my remarks to the common techniques of applied ecology that have been used in this country, with varying success.

The development of vegetation is controlled by climate, soil and biota and a change in vegetation can be effected by changing one or more of these factors.

It is extremely difficult, if not impossible, to bring about by artificial means, any fluctuation in climate, large enough to upset the normal course of succession. I do not minimise in this connection the probable role of artificial rain making, but this is as yet a far cry. No one therefore attempts at the change of climate in applied ecology. But by creating in conopy small openings modification in microclimatic conditions of the forest has been brought out. For example light intensity, temperature etc. have been changed by manipulating the conopy in some sal, deodar and silver fir forests of India.

Soil conditions can be changed, though to a limited extent; the change being most phenomenal in the humus layer. It is this layer, which mostly matters when dealing with applied ecology.

The common techniques that are in use in this country are hoeing, mulching, contour trenching, etc. in forest areas. The exact ecological changes resulting from these techniques have not been studied adequately in Indian forests but moisture conservation, aeration or distribution of food material in the soil body is presumably the result. The operations are done to stimulate the growth of tree seedlings and that ultimately results in the acceleration or retardation of succession along a particular line.

In some areas, the above techniques have helped in the perpetuation of sal and silver fir communities by retarding the successional development of vegetation to communities with less important species.

The biotic factor is the most powerful and most commonly used, for its low cost and maximum effect, in applied ecology.

The conversion of grassy areas to *Pinus longifolia* in some tracts of the Siwaliks is achieved by mere closing it to grazing. The regeneration of some *Strobilanthes-balsam* type of silver fir forests has been claimed by grazing. Fire helps the regeneration of *Pinus longifolia* and inhibits those of silver fir and spruce. In raising artificial plantations of a number of species the vegetation is clearfelled, debris burnt, and ashes scattered before re-planting the area. The present state of most of the sal forests is considered to be due to fire conservancy, giving sal an advantage over other species.

Shifting cultivation in the past has been a powerful tool in upsetting the normal course of succession. The predominance of blue pine and deodar forests in large tracts of Kulu and Bashahr Himalayas is due to partly shifting cultivation. The normal climax here is *Quercus incana* community, and lopping, felling fire have destroyed it from large areas.

The planting of conifers in a number of hill stations, e.g., Simla, Mussoorie and Chakrata has altered the nature of succession considerably. Mention may be made of *Cryptomeria* plantations in Darjeeling district and *Casuarina* on sea coast. If allowed to stay for long enough periods of time these may modify the successional development of indigenous vegetation in the area.

The practice of weeding, shrub cutting, thinning, forest management especially improvement felling, brings about large changes in the normal successional development of vegetation.

Although the above techniques in applied ecology have been in use for a long time the fundamental data regarding these have not been collected so far. The necessity of such fundamental studies has now been keenly felt and the Symposium on "Vegetation Types of India" has formed on "Indian Council of Ecological Research." This council includes specialists in Soil Science, Agronomy, Soil Conservation, Zoology, besides foresters and Ecologists. It is presided over by the Inspector General of Forests, Government of India and is to co-ordinate and expand ecological studies on all types of vegetation in India. It will also help in the planning of applied ecological research in different fields of human activities.

10. F. R. BHARUCH (Bombay) dealt with grass land improvement and socio-ecological point of view.

11. P. S. SRINIVASAN :

It is gratifying to note that an ad-Hoc committee consisting of experts in various branches concerned such as Botany, Agricultural Meteorology and Silviculture has been recently formed with view to advance the science of Applied Ecology in India. Also Dr. F. R. Bharuch indicated that the study of distribution of flora and fauna in India will be taken up immediately. I feel that the value of such a survey will be very much enhanced if the 'intensity of distribution', "population studies" of flora and fauna of India is made. This can only be accomplished by restoring to sampling technique and hence the first step should be to evolve the most suitable sample size and structure to find out the percentage to be sampled to yield the necessary information to the required accuracy or precision.

Also if possible side by side with this survey the study of environment that has given rise to the particular development of flora and fauna should be undertaken. This aspect of the study was rightly stressed by the visiting foreign delegates from U.S.S.R.

12. **PROF. SHANTI SARUP** (Jodhpur) (In Absentia) : *On some Problems in the Immobilisation of the Indian Desert.*

The main problem of the selection of species to be used for the control of the loose sand is twofold—(*i*) the selection of species for perennial cover and the selection of species for cover during the rainfall. Of the local perennial species. *Prosopis spicigera* Linn and *Calligonum polygonoides* Linn might be used to some extent. *Prosopis juliflora* DC. (P. grandulosa) which is less woody and grows more rapidly, however is more suited than the native species. It coppices well and regenerates naturally. Its water requirements are also not so great as that of other species tried in deserts in other parts of the world. It is also suitable for covering the rocky areas and some parts have been successfully afforested with this.

Calligonum polygonoides Linn is also a useful plant for being introduced in the interior of the desert.

During the rains the commonest plant is *Tephrosia purpurea* Pers. It covers the soil. The root and dry branches remain in the soil even after the rains and may continue as such till late in the season. It is probably a recent introduction and is spreading quickly. Its cultivation along with those of other species should be extended into the interior of the desert. It is also useful for covering the sand dunes. At such places *Saccharum spontaneum* Linn has proved very useful.

These species are able to some extent to control water erosion.

Some of the other lines of work in this direction with problems of their own as discussed in the paper are :—

- (*a*) The improvement of grazing lands by rotation, closure and the introduction of legumes.
- (*b*) There is constant breeze in the desert for major part of the year which could be used :—
  - (*i*) for wind mills for drawing water and as a source of energy for other purposes.
  - (*ii*) As an aid for artificial rain making during the period it is charged with moisture.

  and whose effect is to be counteracted by
  - (*i*) Road side planting and planting along railway tracks.
  - (*ii*) Wind breaks, shelter belts, development of oases etc. to minimise wind erosion, dessication and march of the desert.
- (*c*) The problem of salt in the soil and its removal by planting.
- (*d*) The control of destruction of vegetation and deterioration of the area.
- (*e*) Co-ordination of studies and afforestation work done by the various agencies and the public sector and formation of an overall organisation.

13. **SRI GURDIAL SINGH LAMBA** (Jodhpur) (In Absentia) : *Fixation of Shifting Bands in the Indian Desert by means of Vegetation.*

The Indian Desert occupies an area of approximately 80,000 sq. miles. Its control and reclamation might provide new land for the surplus population of the country. This desert is not treeless, rainless and uninhabited piece of land. It is believed that it was well wooded and fertile two to three thousand years ago and desert conditions have set in the recent past and are gradually accentuating. Due to excessive uncontrolled grazing and unwise exploitation of natural resources by man, wind erosion has set in and stabilised sand dunes are being transformed into mobile shifting sands. Thus the slow work of nature which was going on for centuries in stabilising the sand dunes has been reversed and moving sands are engulfing the rich adjoining fields, and smothering walls, buildings, roads and railway tracks. These mobile sands can be reflexed by protection and conservation of existing natural vegetation supplemented by artificial work.

The first essential is to arrest the movement of sand by mechanical devices temporarily but vegetative cover must be established for permanent reclamation. Wooden pallisades or fences may be erected to break the force of wind and catch sand. The best way of arresting movement of sand is to spread corn-stalk, brush wood or town refuse and to simultaneously sow and plant sandbinding grasses, shrubs and creepers but is rather expensive. Another method is by planting fast growing species in belts of 3 or 4 rows at about 200 feet intervals. In a few years the growth in the belts will be sufficient to afford adequate protection to anything planted in between. Grasses and shrubs growing naturally on blown sands are recommended to be sown or planted first. After the site have become stable, local tree species or exotics can be green. In course of time with the addition of humus, the soil may become suitable for growing even agricultural crops.

The Chairman summarised the observations of various participants and spoke stressing on the desirability of intensive study of Ecology both in its fundamental as well as applied aspects

Section of Zoology and Entomology

Jointly with the Sections of Botany and Physiology.

XVII. STRUCTURAL PHYSIOLOGY OF THE CYTOPLASM.

Chairman: Dr. P. Sen (Calcutta).

1. Prof. VISWA NATH (Hoshiarpur):

It is difficult to name a more comprehensive, if not a more intriguing, subject for discussion. It is, therefore, in the fitness of things that our sectional committee decided to have a joint discussion under the auspices of the sections of Zoology, Botany and Physiology.

Our President was kind enough to ask me some time ago to open the discussion. I readily accepted his kind invitation; but as I sit down to prepare an abstract of my talk and survey the bewildering variety of cells in the animal and the plant kingdoms, I feel that it is impossible for one man to include in his discussion all types of differentiated cells.

There are different kinds of germ cells, and hundreds of varieties of somatic cells in both the kingdoms. It may be said without any fear of contradiction that the cytoplasm of a young undifferentiated cell, be it a plant or an animal cell, is a polyphasic colloidal system in which the suspended particles are too small to be seen under an ordinary microscope. But gradually as the cell grows and the physiological processes of differentiation set in, there appear different kinds of cytoplasmic 'inclusions', which are the visible expressions of those processes—the physiological processes themselves being entirely beyond our ken.

There is a vast and bewildering array of these 'inclusions', which appear in the cell during physiological differentiations. These may be roughly placed into two categories—the protoplasmic and metaplasmic, although it is impossible to draw a sharp line of demarcation between them. The Golgi bodies, the mitochondria, the centrosomal system, the plastids of plant cell, and at least a part of the achromatic spindles of dividing cells may be cited as examples of active cytoplasmic 'inclusions', which are capable of growth and self-perpetuation. The secretory granules of gland cells, the Nissl granules of nerve cells, the protein and the fatty yolk of ova, the nucleolar extrusions of certain ova, and the starch and aleurone grains etc., of plant cells are examples of dead, inert, metaplasmic material.

In this paper the author deals with those physiological differentiations in the cytoplasm of the growing animal germ-cells, which are partly reflected by changes in the morphology, chemistry and physical state of the mitochondria, the Golgi bodies, the centrosomal apparatus, the achromatic astral system, and the nucleolar extrusions.

Recently the nucleic acids of the cell, both DNA and RNA, have received a good deal of attention at the hands of biochemists; and I believe Dr. B R. Seshachar will enlighten us with regard to the existence of these acids in the cytoplasm and their connection with the formation of cell proteins.

2. DR. H. N. RAY (Calcutta) : *Some observations on the cytochemical pattern of certain parasitic Protozoa.*

In recent years our conception about the cell as a functional unit has undergone many changes. According to the modern conception every cell is visualised to have, besides its specific morphological identity, a normal cytochemical pattern of its own which is responsible for its very existence, reproduction etc. The cytochemical pattern of *Entamoeba histolytica, Trypanosoma evansi* and *Eimeria tenella* will briefly be discussed here while my colleague Dr. P. C. Sen Gupta will deal separately with *Leishmania donovani, Plasmodium berghei* and *Balantidium coli.*

Entamoeba histolytica :—

The chromatoid bodies contained both RNA and DNA and gave positive reaction for alkaline phosphatase as well as for acid phosphatase. These bodies were found to take part in the formation of the inner membrane of the cyst-wall. Alkaline phosphatase was also present in the nuclear chromatin and karyosome and also exhibited a bilaminar reaction at the surface layer of the cell-body. Glycogen was present in both cystic and the trophic forms. Mitochondria were found to be intimately connected with the oxidation-reduction phenomenon.

Trypanosoma evansi :—

After treatment with antrycide (a trypanocidal drug) a sharp rise of acid phosphatase activity in the nuclear membrane and the cytoplasm was noted, while a general decrease of alkaline phosphatase activity was evident in the nuclear membrane, karyosome, kinetoplast and all along the length of the flagellum. A considerable increase of reserve mucopolysaccharide in the cytoplasm was also apparent in the treated organisms. The above changes suggested an attempt on the part of the organism to offset the action of the drug. No such change was noticed in trypanosomes obtained from splenectomised rats in which the infection could not effectively be controlled with antrycide.

Eimeria tenella :—

The gradient of reaction for the RNA and for alkaline phosphatase was found to be directly proportional to each other and to the tempo of the physiological activity of the parasite, the reaction being more intense when the rate of multiplication was high and the rate of protein synthesis, presumably, also very high, and *vice versa*. This suggested that RNA along with alkaline phosphatase was connected with protein synthesis.

Occurrence of alkaline phosphatase in the Golgi region of the second generation merozoites suggested a functional relation between the two. Golgi complex appeared to secrete the alkaline phosphatase for the purpose of synthesis taking place at this site.

The association of alkaline phosphatase and the hyaluronic acid type of polysaccharide (HAP) in the nuclei of all endogenous stages, peripheral globules of macrogametocytes and in the oocystic membrane suggested possible correlation between alkaline phosphatase and the synthesis of HAP.

Mucopolysaccharide occurred in the cytoplasm only and by dint of its hydrophilic character was found to be of value to the parasite in its various stages of the life-history. Highest concentration of mucopolysaccharides was attained in the second generation schizogony, a stage at which the parasites attained immunogenic character.

5-nucleotidase occurred in the karyosome and was perhaps concerned with the metabolism of protein.

DNA occurred in low polymerised form in the asexual generation of the parasite, while highly polymerised DNA occurred in the nucleus of the macrogametocytes and the male gametes. Oocyst nucleus was devoid of DNA, though about 12% of them had DNA in the cytoplasm. *De novo* synthesis of DNA during sporulation is suggested, as the nuclei of the sporozoites contained abundant DNA.

3. Dr. SIVATOSH MOOKERJEE (Calcutta): *Nuclear-Cytoplasm Dependency in Radiated Cells.*

Structural alteration of an enzyme, in the form of its disappearance and reappearance, in a cell is indicative of a nuclear—cytoplasm dependency. Active trophic forms of amoebae were radiated by million-volt X-ray generator at 600r within half-hour of radiation, loosening the alkaline phosphatase reactions in their cytoplasm. The nucleus gives a strong enzyme reaction. However, the enzymatic reaction of the nucleus becomes progressively lowered in next two to three hours of radiation. Such radiated amoebae are capable of living a physiologically subnormal life only for a short period. Within five hours, the enzymatic activity of nucleus visibly revives into its fold. The cytoplasm can only attain its alkaline phosphatase reactivity at a later period when the nucleus has fully regained its normal reaction (Mookerjee and Hajra). Results on radiated cells of human cervix cancer (Mookerjee and De) and on chick embryos (Mookerjee and Bose) give a similar evidence of an initial cytoplasmic denaturation of alkaline phosphatase followed by a subsequent nuclear disintegration.

The timely behaviour of the appearance and disappearance of alkaline phosphatase in amoeba gives a scope to argue that, (1) the cytoplasmic phosphatase is more fragile to radiation in losing its reactions but the nuclear phosphatase is more sturdy because it is affected after the cytoplasm; (2) during the physiological substance-regulation the nucleus seems to play a major rôle, *a priori* appearance of alkaline phosphatase is necessary in it for a later reappearance of the cytoplasmic alkalnie phosphatase.

4. Dr. AMIYA B. KAR (Lucknow): *Crook's change in the cytoplasm of basophil cells of the pars intermedia after ACTH treatment and its physiological significance.*

Crook's change refers to an aggregation of basophilic granules of the pituitary basophils at certain location(s) and the hyalinization of the rest of the cytoplasm. This change, however, does not signify any degenerative condition, but on the contrary, is an expression of altered physiological state of these cells. In connection with our studies on the identity of ACTH we observed that prolonged administration of this hormone to kittens causes pronounced hypertrophy of the basophils of the pars intermedia and an aggregation of basophilic granules in a perinuclear manner indicative of Crook's change. These phenomena undoubtedly indicate an enhanced secretory activity of the basophils and as these are solely responsible for the elaboration of intermedia in kittens, it is logical to interpret that ACTH stimulates the output of intermedin. Besides, acceleration of cytoplasmic alkaline phosphatase activities in the basophils after ACTH treatment or increase in intermedin contents as shown by actual assay of pituitaries provides evidences which also point towards an enhanced production of intermedin.

These findings suggest that (1) ACTH can influence pigmentation only in an indirect manner through a stimulation of intermedin production but it has no direct pigmentogenic property, and (2) the appearance of pigmentation on the body in certain diseases characterized by an excessive output of pituitary ACTH (Addison's disease, Cushing's syndrome, some acute stress conditions) may be ascribed to a stimulation of intermedin production by the trophic hormone.

5. DR. P. C. SEN GUPTA (Calcutta(: *Cytochemical observations on certain parasitic Protozoa, viz., Plasmodium, Leishmania and Balantidium.*

Mitochondria and Golgi complex.

These structures can be demonstrated in the cytoplasm of the plasmodia studied viz., *P. berghei* and *P. vivax,* and in leishmanial flagellate and *B. coli,* by appropriate supravital staining techniques. The shape and size of the mitochondria vary from minute grains in the plasmodia, to small dot or rod-shaped structures respectively in the leptomonads of *L. donovani* and *B. coli.* These structures show some movement along the cytoplasmic current in the *Balantidium* and slight movement in the other two. Evidence of active oxidation-reduction phenomenon is noted in the plasmodia but not in the other two parasites. Golgi complex is present in the form of minute to relatively larger spheroids in these three Protozoa, the size varying with that of the organism.

Nucleic acids.

The chromatin of the plasmodia contains a minute amount of DNA, and RNA is also one of its constituents. The cytoplasm is very rich in RNA. The nucleus and the kinetoplast of the leishmania and the leptomonad forms of *L. donovani* contain DNA, and the cytoplasm stains light with pyronin. In the *Balantidium,* both the macro- and the micronucleus contain DNA and the basal granules of the cilia are also Feulgen-positive. The cytoplasm stains lightly with pyronin. RNA enters into the composition of the nuclei of both *L. donovani* and *B. coli.* Cysts of *B. coli* show intense reaction for RNA, in the cytoplasm.

Polysaccharides.

Polysaccharides cannot be demonstrated with certainty in the plasmodia and *Leishmania donovani;* but the cytoplasm of *B. coli* contains a large amount of polysaccharides most of which is glycogen; the cysts show more intense reaction.

Alkaline phosphatase.

Alkaline phosphatase is present mainly in nucleus of all the three classes of Protozoa, viz. Sporozoa, Mastigophora and Ciliata, but the cytoplasm shows diffuse and weak reaction in all cases; the border of the parasites showing somewhat more marked reaction than the rest of the cytoplasm. The following cytoplasmic structures show the presence of the enzyme : kinetoplast of *L. donovani,* basal granules of the cilia of *B. coli* and the walls of the cytopyge.

In addition, a number of cytoplasmic granules of *L. donovani* (leptomonad form) shows the presence of alkaline phosphatase.

It has been found that the intensity of reaction was much less in balantidia obtained from cultures in Dobell's medium than in those in faecal smears, though the distribution of the enzyme was identical.

Comments.

Mitochondria are believed to contain proteins, glutathione, lipids, enzymes and vitamins, and are regarded as store of metabolic material, as concerned with digestive process and with respiration It is probable that active oxidation-reduction phenomena noted in the plasmodia indicate active metabolic processes being in progress. Absence of such rapid changes in colour of janus green in the other two Protozoa is probably due to different functional activity of these intracellular structures.

The golgi complex is probably mainly concerned in protecting the cell from noxious agents which are absorbed in these structures.

As for the nucleic acid, it is a peculiar feature noted in our study of parasitic Protozoa belonging to different classes, that the Rhizopoda and Sporozoa studied so far, which are lower in the scale of evolution, appear to be relatively rich in RNA and 'makes do' with a minute amount of DNA. The Mastigophora has relatively larger amount of DNA and the even more complex protozoon *B. coli* has a large amount of DNA in its nuclei. More compiex the organism more is its DNA content. Also DNA is present in organelles other than the nucleus, viz., kinetoplast, the basal granules.

It appears that the plasmodia and *L. donovani* do not ingest or store polysaccharides; glucose is obviously utilised as such. The ciliate on the other hand ingests and stores polysaccharides which it breaks down probably into monosaccharides in the course of metabolism.

Encystation of *B. coli* is associated with storing up of relatively large amounts of polysaccharides and the RNA content is distinctly more than that seen in the trophic form. Encystment being only a protecting device and not concerned with multiplication, it is curious to note the 'laying up a store' of food and essential nucleic acids by the ciliate. Even the enzymes necessary for the utilisation of this store are present in abundance.

It is generally held that plasmodia and *Leishmania* absorbed their nutriments by osmotic process. But the presence of a layer of phosphatase in the peripheral margin of these Protozoa seems to show that transfer of metabolites in and out of the body of the animals is by enzyme activity. In the ciliate more complex food is ingested and digested in the cytoplasm and the cytopyge which is an excretory organ has considerable amount of alkaline phosphatase in its wall; the functions of the enzyme may well be similar to those of the epithelium of the large intestine of man. Small amounts of cytoplasmic alkaline phosphatase present in the plasmodia and the *Leishmania* are apparently concerned with the metabolic activity of the Protozoa and those in the *Balantidium* with digestion and metabolism. Low alkaline phosphatase content of balantidia obtained from culture in artificial media is possibly due to soluble and simpler food being made available in the medium, metabolism of which does not require such amounts of the enzyme as in the natural habitat in the bowel.

6. DR. P. N. GANAPATI (Waltair): *Polysaccharide cycle in the cytoplasm of Gregarine.*

Discussed the polysaccharide cycle in the gregarine (Sporozoa-Protozoa) *Grebneckiella pixellae* parasitic in the intestine of the Centipede *Scolopendra morsitans*. The polysaccharide is paraglycogen occurring as discrete bodies scattered in the cytoplasm. These bodies are more concentrated in the dentomerite than in the protomerite. These bodies accumulate at the centrifugal pole when the organisms are subjected to centrifugation at high speeds. In the sporonts there is a different in the paraglycogen content in the two sexes, the females having more than the males. The paraglycogen could be located only in the female gamates as a few spherical bodies while in the male it could not be traced. In the sporoblasts also these bodies have been observed and they are more in number than in the gamete.

7. DR. A GOPALAKRISHNA (Pilani): *Cytoplasm in the elaboration of male hormones in Scotophilus.*

In *Scotophilus wroughtoni* (Thomas) (microchiroptera vespertilionidae) there is a marked increase in the number and size of the leydig cells of the testis during the breeding season. No mitotic activity was noticed in these cells and hence the variations can only be explained by the assumption that the intertubular connecting tissue cells get transformed into interestitial cells expressly for the purpose of elaboration of the male hormones. Obviously this indicates that the structure responsible for this change, and therefore for the hormone metabolism of the testis, is primarily the cytoplasm. This is further borne out by the cytochemical analysis of the testis during the different seasons of the year.

8. SRI S. R. U. RAO (Pilani) : *Behaviour of mitochondria in Scorpions.*

The mitochondria do not arise "de novo" as it was assumed. It has been shown that there are still smaller bodies in the cytoplasm known as microsomes (thanks to the discovery of Claude) which get themselves converted into mitochondria. Our idea of the "de novo" origin is more due to our not finding better methods, I mean for want of the recent modern techniques, to search for such smaller bodies which are responsible for the origin of mitochondria. Another idea which relates to the importance of mitochondria (whose importance is very much lessened if we assume the de novo origin of mitochondria) is that in some scorpions during spermatogenetic divisions the mitochondria behave almost, if not exactly, like the chromosomes, particularly with reference to their distribution during the two divisions.

9. DR. S. M. DAS (Lucknow) : *Contractile Vacuole formation in Amoeba.*

The story of the formation of contractile vacuoles in *Amoeba* is far from complete. That there may be one or more contractile vacuoles in any one given species is known. But how do they first arise? What is the structural physiology of the contractile vacuole? In one species of *Amoeba* (*A. verrucosa*), we have observed that besides the golgi bodies reported by Brown around the newly formed vacuoles, mitochondria concentrate in the particular region of the cytoplasm and show great activity. The mitochondria appear to enter the golgi region after being elaborated in the cytoplasm adjacent to that region. The secretion droplets are formed within the golgi spots. The first stage appears as scattered granules, the second as C-shaped agglomerated granules, and the last and third stage may be defined as the ring stage with the small formative vacuole lying inside each ring thus formed.

That mitochondria represent elaborated products which are employed as sources of matter and energy in cell activity is well known. Dr. Sen Gupta in his discussion suggested that mitochondria have two functions in cell activity : firstly in the digestive process and secondly respiratory. Our studies show that a third function viz secretion in the formation of vacuoles in *Amoeba* may be added. The golgi bodies give rise to secretion droplets and presumably one of the materials for the synthesis is furnished by mitochondria. The girdle disappears after the formation of each drop in the cytoplasm. These watery drops coalesce, form larger vacuoles, and finally by osmoregulatory activity the vacuole expands and throws its products outside the cell.

XVIII. MECHANISM OF GASTRULATION.

Chairman : DR. P. SEN (Calcutta).

1. PROF. M. A. MOGHE (Pilani) :

All embryological work till the investigations of Roux and Driesch was purely morphological and too much emphasis was laid on the germ layer theory and its assumed phylogenetic significance. In 1883, Roux enunciated the view that development proceeded by mosaic-like distribution of potencies. Driesch's announcement that he obtained an entire larva from an isolated blastomere of sea-urchin seemed to negative Roux's theory. But subsequent research on differentiation of poplasmic material and its distribution to blastomeres during cleavage brought out the concept of 'time element' up to which the potencies may or may not be similar. The brilliant work of Spemann and his discovery of the organiser, Conklin's work on cell-lineage and Born's transplantation methods have contributed to the modern concepts of gastrulation.

Modern concepts deal with the mosaic theory of development, the distinction between the mosaic and the regulative eggs, determination and the nature of chemical processes during gastrulation.

Spemann found that up to a certain stage in gastrulation the fate of most of the embryonic regions is not irrevocably determined. One region of the amphibian embryo is, however, less plastic. It contains within it the influence which determines the fate of the regions with which it comes in contact. Roux made further distinction between dependant differentiation and self differentiation. By 1909 the concept of determination by morphogenetic stimuli was well known. Spemann further distinguished between primary and secondary organisers. The state of the reacting tissue is as important as the tissue itself.

Induction usually occurs as a reaction between three factors: the graft, the overlying tissue of the host and the organising centre of the host. In induction, we are confronted with two determinations: that of presence and that of character. The term evocation was suggested for the first type and the term individuation for the second.

It was found that ooplasmic material shows differential susceptibilities to poisons. This selective sensitivity suggests the region of highest metabolic activity. In 1928, Child attempted to include organiser concept in his theory of physiological gradients. The organiser has an increased susceptibility to a number of chemical substances. There is also a thermal gradient.

The animal-vegetal gradient was established for distribution of glycogen, lipids, proteins, and the SH groups associated with proteins. During gastrulation a new centre of synthesis of ribo-nucleoproteins makes its appearance. The localisation of alkaline phosphatase throws considerable light on the problem of primary morphogenesis. Other chemical studies relate to the elimination of carbon-dioxide by isolated organizer, oxygen consumption and the measurement of respiratory quotient.

2. DR. A. GOPALAKRISHNA (Pilani): *Gastrulation in Mammals.*

The definition of the word 'Gastrulation' is derived mostly from the study of the early embryology of invertebrates and lower vertebrates. The classical definition laid stress on the conversion of the unilaminar blastula into a bilaminar condition resulting in the establishment of the endoderm and incidentally the formation of the archenteron. But recent experimental work on the lower vertebrates have revealed that the central point of interest in gastrulation is the formative movements of cells culminating in the laying down of germinal layers. In either case the result of gastrulation is the formation of the archenteron and the endoderm.

On the basis of these definitions the analysis of the gastrulation in mammals is rendered complicated because the conversion of the blastula into a bilaminar gastrula with the establishment of archenteron is apparently quite unconnected with the formative movements of cells resulting in the establishment of the germ layers of the embryo. This is because in mammalian development extra-embryonic structures are laid down much earlier than the embryonic structures, so that even before the primordial structures of the foetus are differentiated the embryo has all the essential germ layers and archenteron. The formative movements resulting in the orientation of the germ layers are delayed till after the formation of the amnion.

We are, therefore, confronted with the problem of establishing the homologies and analogies of the different processes in the mammalian development with those of lower animals—particularly the anamniotes. At best gastrulation in mammals may be considered as consisting of two apparently disconnected phenomena—the formation of the endoderm and archenteron, and the formative movements resulting in the establishment of the blastopore and embryonic germ layers in their definitive dispositions.

A clearer understanding of the process in mammals will throw light on one of the most fundamental problems in mammalian development—the homologies of the extra-embryonic structures such as the yolk-sac, the amnion and the allantois. That the mammalian yolk-sac is homologous to the archenteron of lower animals is substantiated by the fact that during early developmental history the yolk-sac is the main structure concerned with the nutrition of the embryo. Recent findings in some species of chiroptera, in which, during development the yolk-sac undergoes changes in its histology to get converted into a gland-like structure recall to our mind the potency of the gut endoderm to give rise to glands during ontogeny. Very little can be said regarding the homologies of the amnion and the allantois. Until their homologies are thoroughly established they can at best be considered as ontogenic adaptations of the amniotes in general and of mammals with special reference to the allantois.

3. Dr. S. MOOKERJEE (Calcutta) : *The importance of the morphogenetic movements in the mechanics of gastrulation.*

The transformation of an embryo from its blastula to gastrula condition is mainly possible through the translocation of the cells. The morphogenetic movements of the embryonic cells carry them from one to the other region of the embryo—a necessary precondition for the tissue-differentiation. A discussion will be posed here to show the eventful part of cell movements in the mechanics of gastrulation.

At the time of amphibian gastrulation, when cells are invaginating through the dorsal lip of the blastopore, we have placed the lateral plate mesoderm cells in place of the organiser and *vice versa* (Mookerjee 1953). Under the new contingency, the morphogenetic movements of the cells occurred and the lateral plate mesoderm differentiated into notochord and a feeble induction resulted.

The morphogenetic movements in a chick blastoderm are very sensitive to X-rays. Our studies (Mookerjee and Bose, 1953, and Bose and Mookerjee, 1954) have shown that high dosages of X-rays (over 600r) may interfere with the process of cell movements; consequently there may be failure of primary and secondary inductions and causation of defects in the individuation.

Individual cells of embryos, when performing specific morphogenetic movements, have been isolated, and experimental morphodynamics were initiated to them by mild hydrolysis in a sublethal dose (Mookerjee 1952). Mookerjee, Denchar and Waddington (1953) have isolated a moiety of cells undergoing a particular type of histological differentiation and tested the intracellular morphogenetic forces operative between them.

One of the major issues of gastrulation problems focuses round the problem of specific types of morphogenetic movements of embryonic cells which set the stage for the evocator-competence reactions. We are so far almost ignorant of the inherent factors responsible for bringing about the cell movements inside the embryo, their interactions and final differentiation into a structural pattern.

4. Dr. SHYAMA CHARAN (Gwalior) :

A. Information regarding the formation of the blastocoel cavity in Herpests : In this animal a blastocoel cavity is noticeable even in the 5-celled stage.

B. Information regarding Rhinopoma :

(*i*) Endoderm is formed out of the embryonal mass as a result of delamination. This layer grows all round and underlies the trophoblast.

(*ii*) The trophoblast does not disappear in Rhinopoma as it does in some other forms as stated by Gopal Krishna.

5. **SRI VINODKANT CHUNILAL SHAH** (Baroda) :

Apart from certain specific histochemical work, it is a modern trait to study the appearances which the eggs present after staining by vital dyes. There has been a tendency to interpret the effects as due to differences of pH inside the cells. This suggests that differences do exists between the cytoplasm of these regions. Hence differentiation of pH in different regions of egg and also that of different types of eggs, have important significance in the mechanism of gastrulation.

Section of Anthropology and Archaeology.

XIX. TRIBAL WELFARE AND REHABILITATION.

Chairman : DR. B. K. CHATTERJEE.

1. **DR. NABENDU DATTA-MAJUMDER** : *Tribal Welfare and Rehabilitation.*

The total number of Scheduled Tribes in India is 212 having a total population of 19,111,498. That is, the Scheduled Tribes form 5·36% of the entire population of India. The tribal peoples belong to different ethnic and cultural types. They live in various economic stages ranging from hunting and food gathering through shifting and terraced cultivation to plough cultivation in the plains. The extent of their contact with non-tribal peoples has also a wide range of variation resulting in different degrees of acculturation.

The problem of tribal welfare and rehabilitation is intimately linked up with the question of what should be the place of the tribal peoples in the national democratic set-up of India. After discussing the different schools of thought on the latter question the writer of this paper holds the view that the solution lies in the integration (as distinct from either isolation or complete assimilation) of the tribal peoples in Indian society. This integration is quite compatible with heterogeneity of cultures. The different component groups in such an integrated socio-economic-political set-up while maintaining their social distinctiveness and traditional background will acquire certain common denominators of Indian national culture valued by all and thereby develop a sense of national unity.

The measures necessary for tribal welfare and rehabilitation are bound to vary with the stages of socio-cultural development of the different tribal groups. The hunting and food-gathering Birhor, Korua and Hill Maria cannot be subjected to the same treatment as the Juang, Pauri Bhuiyan and Kandh shifting cultivators or the Munda, Oraon and Santal plough cultivators in the plains. The transition of the tribal peoples from their tribal economy to our national economy must be planned and piloted in conformity with the cultural matrix of the social groups concerned. In other words, the desired integration of the tribal groups in the national democratic set-up of India has to be brought about without suddenly uprooting them from their traditional cultural mooring and thereby causing them irreparable physical and psychological damage.

2. **DR. J. D. N. VERSLUYS** : *Tribal Welfare and Research.*

At the two Conferences held at New Delhi in June, 1952 and Lohardaga in November, 1953 the need for research in connection with tribal welfare was stressed.

In some States research centres have been set up or are in preparation, but one does not gain the impression that research is actually considered to be an essential factor in tribal welfare work. The term welfare work should be taken in its widest sense as to include measures against soil erosion, or to promote acculturation, or improved agriculture, or better health, etc. It may be useful to make it clear that the research to be carried out should be immediately connected with the specific kind of welfare work envisaged in a particular area and not take the character of general research into all the aspects of tribal life which would require more time and personnel. This "directed" research should of course make full use of existing knowledge available with officers of various Government Services and non-officials or in existing reports. However, it will be necessary to investigate how far all this is still applicable as important changes may have occurred meanwhile, and particular attention should be paid to local differences which may occur in the same tribe even within relatively small areas. Non-tribal as well as tribal groups of the population may have to be included in the survey.

3. Sri A. BHATTACHARYYA (In Absentia) :

Without proper understanding of the sentiment and cultural background of a people any work undertaken in the name of 'welfare' among them naturally leads to disastrous results. Moreover no programme even on a regional basis, not to speak of all India, can be adopted for tribal welfare. For though due to various circumstances various Indian tribes have concentrated themselves on certain difficult parts of the sub-continent, yet it is not a fact that they have been able to develop social and cultural integrity in each and every area inhabited by them—they live as neighbours and though economically they share the same fate, yet each of them retain its own characteristics, social, cultural and linguistic. The historical background of the development of socio-cultural life of each tribe is also different. The example of Chota Nagpur Division of Bihar can be cited. The aboriginals living over this area are divided linguistically by two broad divisions—one Austro-Asiatic and another Dravidian. Culturally also there are two broad sections—firstly, the food-gathering and, secondly, the food-producing. There are many villages here where both these different groups of people live together as neighbours outwardly sharing a common economic life but inwardly retaining their cultural individuality. A common set of 'welfare' plan have been imposed upon the people. Basic schools have been started with a common carriculum and a common medium of instruction which is Hindi, a language unknown over this area. Oraon which is a well-developed language finds no place among the Oraon children. Munda an equally important tribal language shares the same fate with the Munda-speaking children. This has resulted in little progress in real education of these peoples so far.

As far as rehabilitation is concerned that the nomadic tribes cannot be rehabilitated in agriculture is well-illustrated by the Birjias of this area.

4. Dr. P. N. SEN GUPTA (Calcutta) : *Importance of Dietary and Nutritional Assessments in the Welfare Programmes of the Tribes.*

Before any tribal welfare scheme can be rationally and successfully undertaken one of the most important things to be considered is with regard to their nutrition and health. It is to be understood whether foods are sufficient for maintenance, whether these provide with adequate nutrition, whether the tribes are growing or heading towards extinction, how the deficiency diseases like goiter can be prevented and in what possible ways the dietaries can be improved. Some tribes are living on wild products, some are herbivorous, some are carnivorous and some are lacto-vegetarians. The effects of these different dietary ranges on the growth, physique and health of the tribes can be judged only by proper and extensive scientific assessments.

It is revealed from the nutritional investigations carried out among the Abors, Nocte Nagas and tribes of Tripura State and Travancore that the dietary patterns and their nutritional value and growth of children of two tribes are much better than those of the other two. The cause of this difference has been explained. The possible reasons of the incidence of goiter in one tribe and how it can be prevented has been discussed. Suggestions have been put forward how the dietaries of the tribes can be improved under the existing conditions for better nutrition and better health.

5. SRI AMBALAL VYAS (Bhubaneswar) (In Absentia): *Tribal Welfare and Rehabilitation in Orissa.*

1. There is a special Department for Tribal and Rural Welfare in Orissa to ameliorate the condition of the tribals in the following fourfold way.

(*a*) Facilities for Education; starting of residential Ashram Schools, dayschools, training centres for teachers and workers; giving scholarships, stipends and lump sum grants for higher education, etc.

(*b*) Medical and health programme. Drinking water wells, distribution of medicines, propaganda for cleanliness, etc.

(*c*) Removal of Social disabilities. By legislation and by propaganda.

(*d*) Economic betterment. Priority in giving cultivable waste lands, free distribution of bullocks, ploughs, etc., starting forest, settlements, preventing exploitation by legislation and by starting multipurpose Co-operative societies, etc.

2. There are different categories of tribals in the state. They are at various stages of civilization.

(*a*) Settled agriculturists doing even wet cultivation and raising cash crops like turmeric, ginger, tobacco, etc.

(*b*) Doing mixed cultivation, partly settled and partly shifting.

(*c*) Living partly on shifting cultivation and partly on selling forest produce such as gum, lac, tamarind, kendu leaves for Bidis, honey, grass and hunting, etc.

(*d*) Daily labourers:—Field labour, Mine labour, Tea labour, working as agricultural servants or Domestic servants, looking after cattle, goats, pigs, poultry, etc., looking after mango orchads, pack-fruit trees, etc.

3. Rehabilitation: for whom, why and how of it. Resources; Agency; machinery, approach, etc.

4. A. Evil effects of shifting or axe-cultivation.
   (*a*) Wreckless destruction of valuable timber.
   (*b*) Soil erosion.
   (*c*) Adverse effect on the fertility of the soil.
   (*d*) Floods causing damage to crops, property and spreading sands over fertile lands.
   (*e*) Decrease in rainfall.

B. Where shifting cultivation is unavoidable what precautions should be taken to minimise the evil effects protecting the hill tops and ridges; terracing the lower slopes, etc.

5. Tribals' view point in favour of shifting cultivation. It is a way of life with many. Protection of crops from wild animals; less labour; no further manuring necessary, etc.

6. Orissa Government's forest settlement schemes. Number of families rehabilitated. Acres of land reclaimed. Money spent per family. Do the tribals appreciate Government measures? Defects and drawbacks.

7. How to make rehabilitation schemes successful and popular.

8. How to stop the exploitation of the tribals by money lenders, contractors, land-holders and petty Government servants of the forest, police, Excise and Revenue Departments.

9. Right type of education of the children, social and adult education, visual propaganda, etc.

6. **Sri N. DAS** (Ranchi) (In Absentia) :

Rehabilitation of the tribes who are at the collectional stage of economy has drawn considerable attention from the anthropologists and administrators. Particularly the tribes who resort to the shifting cultivation and thereby destroy the forests are being widely discussed. Destruction of forests lead to decrease in the rain-fall and soil-erosion. The Hill Kharias and the Pahariyas in the State of Bihar are such tribes. The Government of Bihar are spending nearly Rs. 50,000/- annually for the rehabilitation of 100 Kharia families in a prepared land in Dhalbhum. The Pahariya rehabilitation scheme costs lakhs of rupees.

2. Welfare measures in their practical application by far the most manifested in these rehabilitation schemes. Nevertheless scientific studies of these tribes had not so far been undertaken, thereby leading to lacunae and some times frustation among the inmates of those colonies. Cultural anthropologists can be of immense help to the administration. Fortunately the Government of Bihar have established a Tribal Research Institute with its permanent headquarters at Ranchi to study the tribal cultures in scientific lines, and on the basis of them to suggest appropriate welfare measures.

3. One important thing the Anthropologist had been so far missing as example, i.e., the ideas and experiences of ranked administrators. Hence it is essential that all out efforts can now be made to analyse their views.

4. Simultaneously the anthropologists can assist the administration in several ways except their own specific studies thereby they will no more make them curio-hunters, but men of practical approaches.

5. Academic deliberations in the Universities serve their own purposes but they some times do not fit in to the realities. This difference need be hammered out.

6. But appropriate welfare and rehabilitation will not be possible without a thorough study of the cultures of the people concerned by anthropologists who in their return can marshal cooperation from other sister social sciences.

7. **Sri N. K. SYAMCHAUDHURY** (In Absentia) :

The need of better deals for India's widely distributed tribes stands as mighty challange to the Indian Anthropologists. In view of the country's National Plannings a systematic and scientific approach to the nature of the problems should be attempted. Tribal communities should not lag behind in mal-adjusted conditions as social and economic well-spots in the national life.

Hitherto secluded tribal areas will open up as mineral and other resources are tapped with the expanding facilities of the reconstruction projects. But due to cultural and social differences vis-a-vis the local ecological factors there will be variations in the nature of the problems. This factor is of prime importance for to work amongst tribes the anthropologist should not think himself a branded social worker with pocketful of money who tries to improve the lot of some unfortunate human burdens by providing some facilities. Missionary zeal is necessary, not attitude.

Considering the ethnographic past and the present of a particular tribal community in question ways and means for welfare and rehabilitation could be scientifically predicted. The present requirement is (1) to gather objective data and (2) their systematization into ethnographical-cum-ecological areas thereby obtaining the nature and measure of problems. Research planning is necessary.

8. Dr. B. H. MEHTA (Bombay) (In Absentia): *Rehabilitation of Ex-criminal Groups.*

The problem of the ex-criminal tribes is one of the most difficult problems confronting India after Independence.

Need of a scientific approach to guide the proper understanding and treatment of the problems. Present day tendency of a universal approach to entirely different kinds of problems.

The true implications and content of a rehabilitation programme as the primary objective of treatment of ex-criminal tribes.

The historical background and lack of data to reveal who were the ex-criminal tribes. Several possible theories to explain who they are, and how they came to be considered criminals. They are not tribes; but only gangs, groups, small communities, or maladjusted sections of major tribes.

Causes of maladjustment: Individual factors, lack of adjustments to habitat, difficulties of economic life, inability or unwillingness to adjust to law and order of the State, feudal concepts of property, land and forest policies of British Government, conflict with caste system, etc.

Historical evaluation of British approach to the problem, and consequent protection and preventive measures, social legislation, and programmes of adjustment. State comments on social legislation, methods of registration, identification, restriction, and segregation. The failure of British objectives and methods. Causes and consequences of failures; social maladjustments of the ex-criminal tribes aggravated.

The problem of ex-criminal as a heritage of British rule to Free India. Neglect of these communities in the Constitution, and absence of suitable State agency to deal with the problem.

The 1952 legislative measures do not solve the problem; but are only a beginning of solution. Lack of preparation and planning to deal with the subject after legislation.

Suggested methods of rehabilitation and the need for research, experiments, and evaluation of results of prejudices.

Method 1. Rehabilitation on land in selected areas acceptable to them. Importance of allowing a gradual process of acculturation and assimilation.

Method 2. Rehabilitation of small groups, instead of the whole community in areas suitable to them in terms of economic potentialities.

Method 3. Intensive programmes of vocational training for youths.

Method 4. Partial segregation of children, organising an intensive educational programme from 4 to 21 years.

Method 5. Intensive application of community organisation programmes to manageable communities; communities of between 250 to 1000 families. This method will involve:

(*a*) Development of physical area and treatment of the housing problem;

(*b*) Programmes of economic development on a planned basis, preferably on a cooperative basis.

(*c*) Provision of adequate social services for health, education, community recreation, and woman and child welfare.

(*d*) Intensive treatment of social problem found within the community group.

(*e*) Gradual development of leadership from within the community and developing programmes of intensive social participation to prevent individual maladjustments and delinquencies of age groups of both sexes.

(*f*) Intensive case work for maladjusted individuals.

9. Sri SUNARAM SOREN (Orissa):

In Orissa there is a large tribal population. It is noticed that they are in three stages of development. The first are those who are living mixed up with the non-tribal population in an advanced stage of acculturation. The second category consists of those who live in the hill districts, namely, the ex-State areas and the old districts of Ganjam and Koraput. They are poorer and less advanced than the first category. In the third category may be placed those tribal who have their abode on hill tops and in the midst of thick jungles. They are living a primitive life in a most backward condition socially, educationally and economically.

It is the third category of the tribals for whom development work has to be planned very carefully. It is here that help of the anthropologist is necessary for a scientific study of their present condition, their customs and beliefs, to make proper planning for their amelioration. For, a welfare State cannot allow things to develop themselves, effort has to be made to help these people to come up to the level of the average citizen.

It has to be studied how to process of acculturation has grown in respect of the other two classes of tribes mentioned above; it has to be studied in what way efforts made in the past have affected their lives. These facts will help in arriving at some conclusions about the policy to be followed for assisting the third or the most backward category of the tribes in the State. These tribals are addicted to shifting cultivation. The present policy is to bring them down to the plains for settled cultivation. These colonies have yet to be popular. But experience has shown that once a scheme is found suitable to the tribal, he eagerly comes to cooperate in its execution. Our educational scheme (Ashram and Sevashram) may be cited as an example. The Adibasi was presented with a scheme that he liked. Another instance is the use of modern medicines. The Adibasi is still preferring the primitive methods of treatment.

The Government of Orissa have luckily got the suggestions of eminent social workers like the late Shri Thakkar Bapa. They have set up a Tribal Research Bureau with two Research Scholars to assist them to collect information to help them in the solution of these and similar problems.

Section of Agricultural Sciences.

Jointly with the Section of Geology and Geography.

XX. MINERALS IN SOILS AND CLAYS.

Chairman : Dr. R. J. Kalamkar (Nagpur).

1. Dr. B. CHATTERJEE (Sibpur, Calcutta) opened the discussion and read his paper on the *Cation Dissociation of Clay Minerals* :

The essential inorganic part of a soil is the clay material which is composed of one or more of secondary silicate minerals known as 'Clay Minerals'. The common type of clay minerals present in soils are kaolinite, montmorillonite and illite. The clay minerals differ in their capacities for fixation and release of cations. A knowledge of the fractions of cations dissociated from clays is of utmost importance to agronomists as this will supply them information on the ionic environment in which the plant root is growing and will thus help them in drawing up fertilization and liming projects. Development of membrane electrodes has made possible studies of the ionization of cations from clays. The cation activity in clay systems has been found to depend on the type and concentration of clay minerals and also on the nature of cations concerned. The degree of dissociation of the divalent cations is much less than that of the monovalent ones. The ionization of the monovalent cations (Na, K, NH_4) from clay minerals follows the order : Kaolinite>Montmorillonite>Illite but for divalent cations the general order at pH values less than 6·0 is Illite>Montmorillonite>Kaolinite (except that kaolinite is most ionized with barium) while at complete neutralization the ionization of the divalent cations follows the order : Kaolinite>Illite>Montmorillonite. It has been found that the activity of the cations does not increase appreciably on the addition of the corresponding base to the clays over the range of about 20 to 80 per cent neutralization (Base saturation) and as a result the active fraction shows a marked decrease over this range. This observation is very significant in relation to fertilization practices in that if the fertilizer material be inadequate for the entire area it will be wise to spread it over a relatively small area than to apply it in insufficient quantity over the entire field.

2. Dr. S. P. RAYCHAUDURI *and* Sri C. N. RAO (New Delhi) :

There are many mineral fertilisers in India which require to be properly exploited for increasing the crop production. Deposits of nitre earth provide the major nutrient nitrogen in which the Indian soils are primarily deficient. Rock phosphate deposits chiefly at Singbhum and Trichinopoly provide the second major deficient nutrient. Minerals providing minor elements like manganese in the form of pyrolusite, boron in the form of bore and molybodenum in the form of molybodenite occur in different parts of India. Deposits of materials useful as soil amendments like lime stone and mare and gypsum are also available in sufficiently large resources.

3. Dr. B. RAMA MOORTHY (New Delhi) :

It was shown earlier that the reflectance spectra of ignited soils can be used to determine the dominant mineralogical composition of their clays. It is now shown that for soils low in organic matter, this can be done from the reflectance spectra of the soils even without ignition and the results are in agreement with the conclusions of Bagchi using X-ray analysis. It is shown further that knowledge of the chief individual members of the different types of clay-minerals present in the soil can be obtained by comparing its reflectance in the violet region before and after ignition. In this way, the presence of the highly hyderated members like montmerillonite and halloysite can be distinguished from others of their own type, if there is practically no change in this violet reflectance.

Semi arid conditions acting on the bassaltic trap rock seem to produce dominant amounts of montmorillonite in the soils. Semi arid and arid conditions on the other hand on the once marine Indo-Gangetic alluvium seem to produce a dominance of illite while perhumid conditions seem to produce members of the Kaolinite group whether the soil is derived from the above alluvium or crystalline geneisses and granites.

Jointly with the Section of Botany.

XXI. PLANT BREEDING METHODS IN RELATION TO PHYSIOLOGICAL AND BIOCHEMICAL CHARACTERS.

1. Dr. N. PARTHASARATHY (Cuttack) :

The two ways in which modern plant breeding differs from that of the past are first, the more conscious direction of breeding research to the solving of definite problems and secondly, the development of a more scientific approach and technique. Breeding for such characters like earlier ripening, better quality, stronger straw, longer keeping powers and resistance to flood, frost, drought, salinity, diseases and pests has now become possible, while until not very long ago, the only character dealt with by the breeder was yield potential. In breeding for all such biological and physiological characters, it is important to have critical tests or correlations to evaluate the character under study and to understand the mode of inheritance of the character.

In many physiological characters like drought and frost resistance, the uncertain nature of morphological, physiological and physico-chemical characters as indices of resistance, has made it necessary to adopt the direct method of testing in the field or by pot experiments in drought and cold chambers. However, by careful studies many useful correlations have been worked out. A cytological study of the tapetal cells in plants grown under cold conditions is made in Japan to determine cold resistance in rice. Even in breeding for disease resistance, where it is relatively easy to incite artificially disease conditions and score the progeny for resistance or susceptibility, simple anatomical or cytological correlations sometimes greatly simplify the breeder's task, e.g., correlation between the number of dead epidermal cell layers and resistance to scab in potato. Other valuable correlations are osmotic pressure in estimating saline resistance, schlerenchyma development in non-lodging studies, micro-chemical tests in estimating oil content in linseed and nicotine content in tobacco, height and thickness of the stem in studying fibre content in jute, thickness of bran layer in estimating nutritive value of rice, gluten content and baking quality in wheat, specific gravity and chipping quality in potato etc.

The actual breeding procedures to be adopted will depend on the nature of inheritance of the character. In certain cases like breeding for disease resistance, the task is complicated by the constant origin of new races of the concerned fungus. Since it appears that in several instances, the centre of origin of resistance genes in the host plant is also the centre of maximum variability of the concerned parasite, the breeder can try to breed for resistance to the most virulent races occurring in such areas. A recent suggestion by an American worker concerning breeding a 'composite wheat variety' against the attack of *Puccinia graminis tritici* can be extended to other crops with similar problem. Such a variety when distributed commercially will be a mixture of many phenotypically similar lines which are genotypically different for resistance. It should however be emphasised that we need more fundamental information on the mechanism of resistance in the host plant and the mechanism of origin of new strains in the pathogen before we can organise breeding for disease resistance on more rational lines.

Finally, cyto-genetic studies are important both to overcome cross-incompatibility problems and to transfer the desirable character along without introducing many undesirable features, when the donar parent happens to be a member of a different species or genus. The role of such studies in potato and wheat breeding methods is pointed out.

2. DR. R. D. ASANA (New Delhi): *Physiological Considerations of the Problem of Breeding Drought-resistant Wheat.*

Since nearly two-thirds of the area under wheat in India has scant facilities for irrigation, breeding of improved varieties for unirrigated land is of obvious concern to us. The plant breeder requires some suitable index or indices of drought-resistance to aid his breeding programme. The results of physiological investigations conducted at the Indian Agricultural Research Institute, with this purpose in view, are reviewed.

The variation in soil moisture, obtaining in unirrigated land, during the life-cycle of the crop has been discussed in the light of the two important soil-moisture constants.

The most suitable criterion of drought-resistance, from agronomic point of view, is yield and as such the influence of drought on physiological processes directly connected with yield should be assessed but unfortunately precise information on this relationship is lacking. The effect of soil drought on the three important ear characters, directly concerned with yield, namely, ear number, grain number per ear and 1000-kernel weight was, therefore, investigated, both under pot and field culture. The effect of each character on yield was estimated by calculating standard regression coefficients and it was found that when soil-moisture was adequate, ear number very largely influenced yield, whereas under deficient soil moisture, the other two characters had more or less the same effect as ear number. It is suggested that varieties possessing high values of all the three characters might perform relatively better in unirrigated land and attempt should be made to breed such varieties.

3. DR. G. S. MURTY (New Delhi): *Biochemical Aspects of Plant Breeding with special References to Wheat.*

For a scientifically planned programme of plant breeding, a knowledge of the nature of the problem, inheritance of the concerned character and its relationship with other characters is essential. Fundamental studies in the field of biochemistry have thrown light on the nature of several characters in crop plants, including wheat. But a study of the inheritance of the biochemical aspects of such characters is a relatively under-developed field of work. Studies of this nature depend in turn on the development of specific tests which should be simple and accurate for measuring the characters concerned. The test should be applicable even for a small amount of the material collected from a few plants or preferably from a single plant so that, it would be possible to collect the data on segregating populations.

Sugar-content and osmotic pressure of the sap are known to be usually associated with frost hardiness in wheat although, a strict correlation of this nature has not yet been established. It is probable that in cases where frost injury is high, carbohydrate-content is low. It has been suggested by some workers that resistance to frost, drought and heat is basically similar and that resistance to one of these adverse conditions denotes resistance to the others. The inheritance of resistance to cold in wheat has been studied by Worzella. Indications were that cold resistance was a quantitative character conditioned by several genetic factors. These studies also included characters like granulation, carotenoid pigment-content, crude protein-content, kernel weight and test weight.

It has been observed by several workers in recent years that phenolic compounds and gums produced in the plant body are responsible for rust resistance. These explanations, however, cannot account for physiologic specialisation. It is likely that serologically distinct proteins, species-specific in nature, might be the basis of physiologic specialisation. It seems worthwhile that greater attention should be paid to this approach to an understanding of the nature of reaction to rust attack and genetic analysis of the R-S factors that appear to be associated with specific proteins in wheat.

4. DR. J. THULJARAM RAO (Coimbatore): *Sugarcane Breeding Methods in relation to certain Physiological and Biochemical Characters.*

The production of good hybrid varieties in sugarcane depends more on finding suitable parents through experimental crosses, on assessing their value, and on raising a large population of seedlings in the hope of chancing on a suitable variety. The criterion for the selection of parents is generally the actual performance of the varieties in cultivation under the various soil and climatic conditions and their behaviour in breeding. In view of the low percentage of selections in the progenies, and the long duration of the crop, it has become necessary to establish indirect correlations between simple morphological, anatomical or other characters and the known economic characteristics so that valuable seedlings may be spotted out during the seedling stage itself.

The chief economic characters in sugarcane are yield of cane and the sucrose content in juice. The former is mainly a function of the physiological attributes of tillering and growth. Suitable parents are available for production of high yielding and/or high sugared types. The existence of an inverse relationship between yield and nitrogen content, if fully confirmed, may necessitate the production of varieties with low nitrogen content. Resistance or at least tolerance to adverse conditions like drought, frost, submergence etc. is necessary in improved sugarcane varieties if they are to survive under the climatic conditions in North India. In view of their good performance under North Indian climatic conditions Co. 205, Co. 285, Co. 453 etc. have been used as parents in breeding for these conditions, and the results have been encouraging. Certain discriminant functions of drought resistance may prove of use in the selection of useful types in the seedling stage. Varieties with different maturity periods have been evolved to suit the needs of the industry. Other physiological or biochemical characters like pith, chemical composition of juice, starch content in stem have been studied.

5. Dr. R. R. PANJE (Coimbatore): *Physiological and Biochemical Characters in Saccharum Spontaneum and their Significance to Sugarcane Breeding.*

The hardiness shown by the present-day hybrid sugarcanes has been attributed by cane breeders to characteristics inherited from the wild parent, *Saccharum spontaneum.* In the wide variation and adaptability shown by this species, much scope exists for choice of parents. A survey of the physiological and biochemical characters in the wide range of variants of this wild cane would therefore be an important step towards the improvement of hybrid canes.

Among the physiological characters concerned in drought-resistance, osmotic concentration of the cell sap appeared to be the most important in the case of *spontaneum;* a survey of about 30 variants to-date has shown a variation ranging from 0·28 to 0·65 molar in terms of potassium nitrate as against 0·30 in *S. officinarum,* and 0·60 in *Erianthus munja.* Grown in graded saline culture solutions, some variants appeared to have greater tolerance to salt than others.

Among the biochemical characters, the sugar content of juice is very important. A survey revealed spontaneums with sugar contents as high as 14% in juice. An interesting finding is that the juices of some variants give negative readings presumably due to an excess of levulose. This fact may have implications on the limits of purity attainable in hybrids; it also emphasises the need for testing varieties by the double polarisation method, especially where invert sugar content is high.

There is a wide variation in the amount of starch contained in the internodes. Starch in juice interferes with clarification. With a proper choice of parents, the breeder may steer clear of this factor, especially as variants of *spontaneum* without starch appear to be homozygous for this character.

While the high polyploidy and heterozygosity of *S. officinarum* variants has placed a barrier in the way of improving progenies, the study of and selection among clones of *spontaneum* would perhaps help to enhance the efficiency of breeding.

6. Dr. S. M. SIRCAR (Calcutta): *Breeding in relation to the Physiology of Rice Plant.*

Problems of breeding rice varieties should be approached from a consideration of the behaviour of the plant towards the environmental factors. A great deal of our present day researches on *ad hoc* experiments have produced little practical value. This is primarily due to the lack of proper consideration of the physiology of the plant. Fundamental knowledge of the reaction of the rice plant towards a set of environmental factors forms the basis of the procedures to be followed for the effective breeding of rice varieties. This is more evident from some of the present day important problems of rice breeding, e.g., resistance to lodging, flood, drought and salinity, varietal differences in response to fertilizers under different climatic conditions, ecological characters of varieties of different regions, improvement of the nutritional value of rice by increasing the protein and vitamin contents.

In lodging apart from the morphological and anatomical considerations, the response of plants to N.P.K. supply under different climatic conditions is to be noted. Similarly the problems of breeding, drought, flood and salinity resistance are associated with the phases of plant development and its metabolic sequences.

Ecological classification of varieties form a very potent factor in plant introduction and improvement by hybridization. Reactions to photoperiods and the prevailing temperatures at different phases of plants are the causative effects of sterility often noticed in rice culture. Lastly time has come to evaluate the nutrition of the different rice grains and to evolve varieties having more food value. This again is determined by soil and environmental conditions.

7. Dr. G. V. CHALAM (Cuttack): *Uptake of Water and Solutes by the Spikelet of Oryza Sativa.*

Experiments regarding the entry and path of water and solutes in to the paddy spikelet have been conducted. For the study of entry of water, initially weighed, basal and apicular portions of paddy spikelets with cut ends sealed were fixed in cork-rafts and floated in water. Weighments were made at intervals of 6, 20, 48 and 72 hours, in comparison to the whole spikelet. It was found that there was absorption at both the ends and the absorption is more up to a period of 20 hours at the apicular end. Later on it was more or less the same. In the distribution of water through the entire surface of the spikelets also up to a period of 15 hours the concentration was more at the apicular end and ultimately after 30 hours the concentration was more at the basal end.

For the entry of solutes iodine, Brown's Silver nitrate method and eosine were studied. In all these experiments three paths of entry were definitely established by testing the kernels. Three paths of entry were found to be viz. (*i*) Inter-locking, (*ii*) Through the middle vein of lemma, (*iii*) Through the non-lignified portion of the lemma over the embryo. In these cases also relatively the entry at the apicular is greater and quicker. It is presumed that the vein ends of the lemma at the apicule are open, which facilitate an early entry.

8. Dr. D. K. MUKHERJI (Calcutta):

During the last half a century, breeding methods have been remodelled and adjusted according to the necessity. The physiological and biochemical characters desired in a variety require utmost care and ingenuity of a breeder and various complex and intricate tests have to be made to achieve his goal. Thus, production of a salt, flood, disease-, pest or drought-resistant or a winter-hardy variety needs testing for the specific characters at various stages of breeding, for wider range of adaptibility, multiple-cross method or testing of F_2 progenies under various soil and environmental conditions is resorted to, and so on. For efficient utilization of manures or for reaction of a variety to other chemicals, a breeder has to resort to special tests involving physiological and biochemical techniques, such as artificial culture of excised embryos or plants in nutrient media etc., and analyse the results at various stages of his breeding programme. For obtaining a variety having seeds of high nutritive value, of higher vitamin content, better baking qualities and so on, similar breeding methods are adopted. Thus, it is not the morphological characters alone which get attention from a modern breeder, but the various physiological and biochemical characters get greater attention from him and the breeding methods are adjusted and remodelled accordingly.

9. Sri M. B. V. NARASINGA RAO (Samalkota) :

Mendelism, comprising the laws of inheritance of characters has for a long time been supposed to be valid only for morphological characters of plants and animals. But later researches have shown that reconsile physiological characters such as flowering duration, various kinds of sterility, resistance to drought, floods drainage of seed etc. are governed by laws of inheritance. It has however, been brought to the foreground that the environment has a very strong influence on the expression of physiological characters and the study of the 'environment' in its broadest sense has become very important for a proper elucidation of the inheritance of physiological characters.

A distinction has to be made of the two terms "Genetics of physiological characters" and "physiological genetics". While the former deals with the genetics of characters, the latter which has been studied by Goldsmith and others deals with the variability of expression of characters but surely under different environmental conditions. Thus the study of the environment has been found to be of paramount importance.

For a long time to come in this country a great deal of importance has to be attached to the study and improvement of 'Yield' of crops. 'Yield' is known to be a complex character, being the net product of the vital activities of organism in question, and it is essential therefore that the particular visible attributes which go to make up the yield have to be given the proper weight in the breeding programme for yield.

'Quality' in crops e.g. lint length, increase content of cane, oil content of seeds, has recently been added to the list of characters, that could be tackled by plant breeding methods.

Characters which would cause loss of damage by wastage e.g. shattering, non-dormancy of seeds, lodging specially in cereals have all been also brought under the purview of the plant breeder and attempts are being made to improve upon these characters. Most of physiological and quantitative characters such as tillering, length of head in cereals for instance, are governed by multiple factors, the ordinary method of genetical analysis heads down and special branch of Biometrical Genetics is fast developing which helps in the solution of these problems.

A subtle distinction may be made between 'biological' characters and 'physiological characters' under the first category may be exclusively included such characters as diseases resistance and resistance to pests or other organisms. But in these characters it has been found that resistance may sometimes be due to certain modifications in the physiological set up of the host organism and this subtle difference may therefore be very small and not real. The problem of disease resistance is a more difficult study as it has to deal with two organisms, the host and the parasite.

It is hoped that with the combined efforts of the physiologist, pathologist and the classical geneticists, plant breeders hope to produce more prolific, better quality and hardier varieties of crops and animals.

Jointly with the Section of Botany.

XXII. PLANT INTRODUCTION AS AN AID TO IMPROVEMENT OF FOOD AND FODDER.

1. Dr. J. C. SAHA (Darjeeling): *Enrichment of Agriculture through Plant Introduction.*

It is now admitted that cultivated plants have definite "centres of origin", and it was from such primary centres that crop plants were distributed to other regions of the world in the course of the long and remote history of human civilization. In fact, the World and the New Worlds have had few cultivated plants in common before the days of Columbus.

The significant part plant introduction can play to revolutionise and enrich a country's plant husbandry is exemplified by North American agriculture. United States of America can hardly claim any indigenous crops other than pecan nuts, blueberries, cranberries, raspberries, concord grapes, some plums and some strawberries. But today the United States grow varied agricultural crops almost all of which have been introduced by the early settlers. However, few of the exotic crop plants cultivated in India have had any plant introduction behind them; and the few that can claim this distinction belong to a category other than food crops.

The discovery of genes and their incorporation through breeding to the production of new forms of better yielding crop plants resistant to pests and diseases and/or tolerant to extreme climatic and edaphic conditions, have given impetus to explore regions, where a particular crop is supposed to be indigenous, to find new or wild forms of related plants with desirable characters so that genes for such characters might be imparted to improve plants already in cultivation.

Since the turn of the current century, several such plant explorations have been carried by the Russians and the North Americans. These have supplied a rich source of breeding materials for improving, among others, such important crops as potato, sugarcane, corn and other cereals, alfalfa, etc.

2. Dr. D. CHATTERJEE and Sri C. L. DHAWAN (New Delhi): *Better Fodder Plants for India.*

It has been estimated that the cattle population of India is 200 million and the livestock population other than cattle (i.e. horses, sheep, goats, etc.) is another 90 million. The problem of supplying suitable and adequate fodder to this vast number, specially during the dry season, is indeed immense and requires consideration by all. While over 16 per cent of the sown area are placed for growing of fodder plants in Egypt, this acreage would hardly exceed 3 per cent in India. In addition to some of our indigenous fodder grasses like the *dhoob, anjan, jerga* and spear grass, a large number of exotic grasses and legumes have been introduced during the present century. Their comparative values lie either in their more vigorous growth or in their better nutritive qualities. The most important of these introductions is the Egyptian clover or *berseem* which has proved of definite value to our country. Other introductions are the Napier grass, guinea grass, Sudan grass and Rhodes grass.

Some of the recent introductions of grasses and legumes which have shown distinct promise as a result of trial at the Indian Agricultural Research Institute, New Delhi and other places may be summarised. The African *Bothriochloa insculpta* and *Brachiaria brizantha,* the Australian *Urochloa* sp. and *Paspalum* *notatum* from Urugauy have been found to do very well under Indian conditions. Besides the Kudzu vine which has been already popularised by the Vivekananda Laboratory, Almora and the I.A.R.I., New Delhi certain other legumes like the Hubam clover, a variety of Vetch from Cyprus, the creeping indigo of Ceylon, *Centrosema pubescens* and *Glycine javanica* have proved promising and should be made known to the farmers. In areas of heavy rainfall like Assam and some parts of South India, the Para grass of South America is recommended, while the blue panic grass (*Panicum antidotale*) which was originally taken from India and improved by selection in Australia, is now successfully re-introduced in the semi-arid zones of Northern India.

3. Dr. NIRAD K. SEN (Kharagpur) : *Improvement of Fodder Legumes in India through Introduction.*

As a nutritous cattle feed and as a soil conserving crop, leguminous fodder plants play an important role in farming. In India most of the legumes used as fodder are pulses or vegetables grown as a catch crop. It is only in recent years that some of them are being raised as farm crops and several of them have only been recently introduced.

Of the recently introduced types *alfalfa* has a great potentiality. Suitable strain of alfalfa, grown in fertile soil under irrigation, is decidedly the best fodder legume. Success of alfalfa over an extensive area throughout the world is mostly due to production of strains adapted to local conditions, in which introduction has played a great role. There is a considerable scope to introduce *Lespedeza* on marginal lands and in regions of acid soil and some of the strains are extremely drought resistant. On steep hillside and in eroded gullies, recently introduced *Kudzu* is performing very well. Among the *clovers* the *Egyptian clover* is gradually becoming popular in the irrigated tracts, but a fair trial has not yet been given to the high yielding types of red clover, white clover and sweet clover. *Strawberry clover* is one of those rare plants which can stand wet alkali soil.

Among the other fodder legumes commonly grown in India like *cowpea, grass pea, horse gram, moth bean, rice bean, velvet bean, Indian clover and fenugreek* the breeder is limited by lack of much variability in his local collections. A greater gene fund should be made available to him by introducing desirable strains from abroad and also by collecting their wild relatives from areas of greatest diversity. In conclusion it may be said that today in India, among all the farm crops, fodder legumes have the greatest potentiality for improvement through introduction.

4. Dr. G. S. RANDHAWA (New Delhi) : *Introduction of Fruit Trees in India and Development of the Fruit Industry.*

Introduction of new fruits and fruit varieties from one country to the other has been made since early time. Many such introductions have been surprisingly successful e.g., introduction of grapes from Spain to Cuzco, Washington Navel orange from Brazil to California and avocado, guava, pineapple and papaya from Tropical America to India. The trade relations existed between India and other Asian countries like Arabia, Burma, China, Malaya and Indo-China as early as the 13th century. Many fruits like date, peach, pear, mango, banana and some citrus fruits were then introduced in India. Later on several temperate, sub-tropical and tropical fruits were introduced in India from Tropical America, Europe, China, Brazil and some other countries.

The introduced fruit trees play a significant role in improvement of our cultivated tree fruits. Many of their desirable characteristics like resistance to drought, insect pests and diseases or high yield and better fruit quality could be transferred to the cultivated forms by hybridization followed by selection and testing of the resultant seedlings. Explorations of wild forms, of fruit trees, from unexplored regions, which are drought-resistant, winter-hardy or immune to insect pests and diseases may greatly help our future fruit breeders in evolving varieties suitable for unfavourable environments.

Introduction of Tropical American date palm (*Bactris utilis*), pecan (*Carya illinoensis*) and tropical apple from Israel is suggested.

5. Dr. H. L. CHAKRAVARTY (Calcutta): *Introduction of Food and Vegetable Plants in India.*

India occupies an advantageous physio-graphical position in having in her extensive territories climate and soil of varied types ranging from temperate dry or temperate moist conditions to moist and dry warm zones. Our extensive fertile plains, lofty mountain ranges, long terai expanse, vast swamps and arid central zone can very well accommodate types of vegetation suitable for settlement from similar localities beyond the seas. We are passing through food crisis particularly as a result of partition after the second World War. Gigantic projects have therefore been launched to face the challenge of food shortage and natural calamities, and Government have taken up the problem of scarcity on a war footing. Agriculture has been given the primary importance in our all round enterprise with the object of flourishing the country with plenty. In this paper the author has attempted to show with reference to plant types that it is worthwhile to introduce certain foreign plants of economic importance in similar ideal Indian climate. These plants include those which have sufficient nutritive value as an article of food or vegetable.

As an experimental measure certain plants may at first be selected for introduction. These may be procured by barter or by purchase. Knowledge of local ecological or meteriological conditions of the importing countries with the conditions prevailing in the proposed area of introduction are prerequisites.

6. Dr. L. S. S. KUMAR (Poona): *Introduction of Forage Plants.*

One of the most important methods of increasing the productivity of food and fodder resources of a country is by plant introduction. Plant introduction dates back to early history of mankind. Plants have been introduced from one country to another by travellers and explorers in early times. Subsequently Government departments have been responsible for introduction of plants of importance. Businessmen, traders and pilgrims have all played a part in introduction of new plants. Probably the greatest exchange of plant material has been between scientists of different countries resulting in introduction of superior types.

Introduction of maize needs a special mention as it has been useful both as fooder and food. Among forage grasses notable introductions include Guinea, Elephant or Napier, Rhodes, Para and Sudan. High importance is to be given to lucerne or alfalfa, berseem and soyabean among forage legumes.

Among recent introductions of forage grasses and legumes the following need special mention. Blue Panic, Japanese Kudzu and Koo babul. There are many other fodder grasses and legumes introduced from abroad that have become adapted and are proving superior to local types.

Plant introduction is one of the means of enriching the economic plant wealth of a country. To do this work successfully what is required is a central and regional organisation on the lines of the Bureau of Plant Introduction of the U.S.A. and similar organisation in other countries. This country should have an organisation to undertake such work on scientific lines.

7. Sri M. B. V. NARSINGA RAO (Samalkota) : *Plant Introduction as an Aid to Improvement of Food and Tackles.*

The romances of plant hunting by different people in different epochs and in different parts of the world make very pleasant reading. The absorbing interest which the early kings and even monks had shown towards gardening has helped the development of plant sciences to a large extent. New crops e.g. tea, coffee, tobacco, oranges etc. have been introduced into new areas and such historical examples are many. These may be termed fortuitious introduction.

After the rediscovery of Mendel's laws and concept of variety as an assemblage of factors, it came to be recognised that for successful and sound breeding programmes it is necessary to have a new and superior germ plasm. The sources of this germ plasm are the large number of varieties available in a particular locality, the large amount of material in the places the crop is long cultivated and the related species and even genera.

A thorough search of all cultivated forms, wild species and even related genera gives valuable results. The explorations of Russian Botanists headed by Vavilov have brought forth results of not only high scientific interest but of immense practical value to plant breeding. According to him the longer a crop plant had been established in a given area the larger the number of allied species that one can find there. It also abounds in a wealth of forms with rare genes and superior germ plasm. By the law of Homologous or parallel variations we now learn in which regions of the world productive large seeded strains, cereals with solid straw, varieties resistant to specific fungus diseases and so on can be found.

Some varieties obscure at the moment may contain valuable genes much needed in the synthesis of a new hybrid. If these are replaced by forms which are superior to them in some respects, they are lost to us for ever. A valuable function of Agricultural Institutes will be to maintain a collection of as many primitive cultivated varieties of the plant. One of their functions will be the analysis of natural populations, a very useful aspect to plant breeding. Such Institutions are the Plant Introduction Bureau started in U.S.A. and other countries.

While agronomically useful genes may be available in cultivated varieties of the crop plant those which contribute special traits, such as resistance to diseases, drought resistance etc. are usually met with in their wild ancestors of the same genus or allied genera and these may be used for synthesising new hybrids with the cultivated types.

A useful technique called the homoclime technique is very helpful to formulate introduction programmes. According to this technique similar ecological or agro-climatic areas are delimited in different countries of the world by the comparison of all available data on climate, geography and soils. It should be useful that this technique be developed in all the countries so that it will be of value in the selection of plants for food and fodder for introduction into the countries in question.

A danger usually concomittant with introduction from other climes is the possibility of introducing harmful pests and diseases along with crop plants. A powerful

Quarantine section has to be set up in each country which envisages plant introduction.

8. Dr. S. KRISHNAMURTHI (Annamalainagar): *Plant Introduction as an Aid to Improvement of Food and Fodder Plants in the Nilgiris, the Premier Hill District of South India.*

The hill zones of India in general represent a region which has shown fairly outstanding success of plant introduction as means of establishing and acclimatising a number of crops vital to the economy of the area particularly and of the nation generally. Cinchona, rubber, tea and coffee are good examples of the benefit of plant introduction. Nilgiri Hill District in Southern India has been especially an active centre of plant introductions for over a century. While being famous for its cinchona, coffee and tea, it has had a number of introductions of food and fodder plants suitable to the hill zones. This paper deals with the success achieved in the Nilgiris in introduction and improvement of fodder plants, and food plants under which are included also the potato, fruits and vegetables, as they are part of food.

Of these food crops, potato occupies the most important place in the agricultural economy of Nilgiris and potato from this district reaches markets of Ceylon, Bombay, Calcutta and other distant places. The first introductions of potato were made in 1822, and the improvement of potato as a commercial crop on the Nilgiris since then has been mainly through introductions of varieties from abroad, varietal trials among these to test performance, and to acclimatise the high yielding varieties. Of all these, the "Great Scot" has till now occupied the front place because of early maturity, round medium tubers, smooth white skin, hard flesh and good keeping quality and yield.

Nilgiri District is one of the very few zones in South India where wheat is grown, and the establishment of wheat on these hills is entirely due to introduction of suitable varieties from abroad. Recently rust resistant types of wheat imported from Australia such as Celebration, Charter, Gebo and Kendu have been promising substitutes for the varieties at present grown in the Nilgiris.

The commercial cultivation of temperate vegetables on the Nilgiris such as cabbage, cauliflower, knolkohl, beetroot, carrot, turnip, peas and beans for which this hill district is famous owes its position to introductions from abroad.

Among fruits, besides the apple, pear, peach, plum and strawberry, the Nilgiri district has achieved resounding success in establishment of such exotic fruits as avocado, cherimoyer, mangosteen, durian and persimmon. Nilgiri district is the only zone in India possessing commercial orchards of mangosteen and is one of the few zones in the world where mangosteen is a success, and this is largely due to plant introduction.

Barley, buckwheat, oats and lentil are other food crops which owe their establishment on the Nilgiris to plant introduction.

Among the fodder and pasture plants, Kikuyu, *Pennisetum clandestinum* introduced from East Africa has widely spread in the Nilgiris. Among others about which record of introductions is available are berseem, subterranean clover. lucerne, napier grass, buffalo grass and guinea grass.

9. Dr. S. M. SIKKA (New Delhi): *Plant Introduction as an Aid to Improvement of Food and Fodder Crops with special Reference to Wheat.*

The rapid advances made recently in plant breeding techniques have resulted in the evolution of superior strains of crop plants and differentiation of ecotypes suitable for cultivation under a wide range of climatic conditions. The introduction of such materials from one country to another and their evaluation and utilization in breeding has been universally regarded as one of the most important methods of crop improvement. This has led to the establishment of Bureaux of Plant Introduction and Exploration in all the agriculturally advanced countries of the world.

There are numerous examples of notable successes achieved in different countries in evolving new varieties of crop plants of great economic value by utilizing introduced varieties either for hybridisation or for direct selection. A classical example is that of *Marquis* wheat, which stood out for years as the greatest achievement in wheat breeding history of United States of America and founded the hard spring wheat industry of that country. The seed sample from which this variety was evolved came originally from Galicia in Poland. The seed subsequently passed through a number of countries, e.g., Germany, Scotland and Canada before it reached the United States where a single-plant selection made therefrom gave rise to the famous variety, *Red file,* which in turn was the parent of *Marquis.* In later crosses, *Marquis* passed on its superior characters to several American and Canadian wheats. The origin of this variety and its subsequent utilization for extensive cross breeding work not only in America but also in other countries shows how plant breeding cuts across and disregards national boundaries to develop products useful to all men and all nations.

The utilization of introduced varieties has played its role in the improvement of the wheat crop in India also. This line of work was initiated during the first decade of this century when the indigenous varieties, *N.P. 52* and *N.P. 4,* were improved for yield and resistance to the smut disease by crossing them with the Australian variety, *Federation.* Since 1933-34, a more systematic and broad-based programme for the collection, maintenance and study of foreign wheats has been followed at the Indian Agricultural Research Institute, New Delhi. From a collection of more than 2,500 exotic wheats, about two dozen varieties have been successfully used for imparting a high degree of rust resistance to Indian wheats apart from immunity from the smut disease. It has also been possible to introduce directly one variety *Ridley,* for cultivation in the hilly tract of Northern India.

The useful results achieved from introduced wheat varieties well justify the establishment of a full-fledged Bureau of Plant Introduction and Exploration in India.

10. SRI HARBHAJAN SINGH (New Delhi) : *Plant Introduction as an Aid to the Improvement of Food and Fodder Plants—Vegetables.*

India grows a wide variety of vegetables not all of which are indigenous to this country. The region comprising India and Burma contributed largely the tropical vegetables commonly grown in this country. Continued migrations of vegetable crops from one region to the other resulted in the rich diversity that we see today. In India, the work on the breeding of vegetable crops has so far received but meagre attention. As such, introduction of plant material from abroad would certainly be expected to play a very important role.

In the future, there seems to be greater scope for introduction and utilisation of new varieties of vegetable plants rather than of wholly new plants. Introductions made in recent years, by the Plant Introduction Section at the Indian Agricultural Research Institute, have shown the vast possibilities of effecting improvements in vegetables through plant introduction. Varieties such as 'Sioux' in tomato, 'Early Badger' and 'Bonneville' in garden pea, 'Philippines Early' in cowpea *(lobia)*, F.A. 17' in sweet potato, 'Bermuda Yellow' and 'Texas Grano' onion, 'New Hampshire Midget' watermelon have given good performance in comparison to local varieties. The tomato variety 'Sioux' and the *bhendi* variety 'Green Velvet' both American, have further been successfully used in breeding better varieties. Special breeding materials such as the male sterile lines in tomato and onion, for the production of hybrid seeds, have also been imported.

Collection and utilisation of wild relatives should also receive adequate attention. The use of South American wild species of tomato and potato is well known. The tomato variety—Hybrid-6 which is rich in vitamin C and sugar content, is a selection made at the I.A.R.I. from crosses made with the wild South American species *L. pimpinellifolium*. In *bhendi* a newly described indigenous wild species, *A. tuberculatus* Pal et Singh, seems to hold promise as breeding material for breeding for resistance to yellow-vein-mosaic in the cultivated crop; it would be worthwhile searching for, and utilising, exotic species of this genus for breeding for hardiness and disease resistance.

If this process of introduction is accelerated, systematized and its scope widened we can expect to make further profitable additions and improvements in our vegetable crop varieties.

11. DR. A. B. JOSHI (New Delhi) : *Plant Introduction as an aid to the Improvement of Food and Fodder Plants—Root and Tubers.*

A considerable range of root and tuber crops is grown in India. Many of these plants, e.g., the aroids, yams and others, are believed to be indigenous to this country. Many of the important present-day root and tuber crops of India, e.g., the potato, sweet potato, tapioca, radish, carrots, turnips and beet are however foreign introductions.

The usefulness of introduced varieties and related species in the further improvement of these crop plants is indicated.

The need of establishing a well-organised central bureau of plant introduction in India for carrying out this valuable work is imperative.

XXIII. TEACHING OF AGRICULTURE.

1. DR. P. K. SEN (Calcutta) :

Teaching of Agriculture has two aspects. One is professional, turning out trained personnel of all categories for the departments of Governments or for private institutions. Another is general, providing an economic foundation of a way of life based on the philosophy of co-existence and non-violence.

The object of education is to develop the faculties of man, thinking and acting, with a view to producing goods and conditions of a happy community life. Food is needed by every body but the overwhelming majority of people is yet unable to meet this primary need. Obviously, therefore, the concerns of food should form an objective basis of education for the community as a whole and agriculture should form an integral part of liberal education.

Placing education on an objective basis of agriculture and allied crafts meeting the primary needs of life, as was advocated by Mahatma Gandhi, would reduce the limiting effects of money on extension of education, promote thoughts and actions of self-help and co-operation among individuals, and advance peace in the world.

Consistent with India's standpoint, the educationists of the country have seen the importance of agricultural teaching from primary to the highest stages of education, in its proper bearings. The principle accepted has yet to be worked out in all its detail in our educational plan. Agricultural teaching has so far been a charge of the Ministries of Agriculture mainly concerned with training personnel for their departments. It has continued to remain so even in the changed circumstances. It is a matter for serious consideration whether or not Ministries of Education should now take up agricultural teaching along with education as a whole. While we need a very large number of trained personnel for our expanding research and development work in agriculture, we need an even larger number of qualified agricultural teachers for our schools throughout the country for above all we have to bring about a change in the background of life with a view to achieving our cherished ideal. Bearing this in mind the following pattern of education is suggested :

Primary or Junior Basic Education
(Age group : 6-7 to 10-11)

General introduction with a view to creating interest in agriculture and allied crafts.

Weightage—25% of curriculum

↓

Junior Secondary or Senior Basic Education to begin with at least in rural areas.
(Age group : 11-12 to 14-15)

Practice of agriculture and allied crafts in a productive way.

Weightage—50% of curriculum

↓

Senior Secondary or Post Basic Education.
(Age group : 14-15 to 16-17)

Agricultural	Weightage	*General*	Weightage	*Technical*	Weightage
Practice of productive agriculture and introduction to its general theories ...	75%	Arts & Science	75%	Practice of productive crafts and technology and introduction to their general theories ...	75%
Humanities and Basic Science ...	25%	Practice of productive Agriculture and allied crafts	25%	Humanities and Basic Science ...	25%

↓ Agricultural ↑ | ↓ Arts, Science, Medical etc. ↑ | ↓ Technological. ↑

Collegiate Education.

↓

Post-graduate Studies : Specialisation.

2. Sri HARISH C. SAXENA (Allahabad) : *Teaching Animal Nutrition.*

Animal nutrition has become a very important aspect of modern livestock production. The nutrition knowledge has advanced tremendously during the last ten years. Further research is continuing to discover new reproduction, lactation and growth factors. With all these developments the subject of animal nutrition is becoming increasingly complex.

Teaching of animal nutrition should, therefore, be planned keeping these developments in view. Most colleges offering degree courses in Agriculture or Veterinary Science teach courses in animal nutrition. The time allotted to the subject, the syllabus and the approach to the subject varies from college to college.

For purposes of a discussion on training in animal nutrition the subject matter may be divided into three specific learning areas:

1. Subject matter areas within the field of animal nutrition and allied subjects to support the understanding of animal nutrition;
2. Techniques considered necessary for an animal nutritionist; and
3. General learning areas considered necessary to give breadth of understanding and appreciation of the physical and social world.

Prominent among those which are extremely necessary for the understanding of the subject matter of animal nutrition are Biochemistry, Bacteriology, Physiology, Anatomy, Statistics, Agronomy, Agricultural Economics and Veterinary Hygiene. Students in most agricultural colleges seem to have an inadequate background in organic chemistry and therefore have difficulty in understanding biochemistry, so necessary for understanding of animal nutrition. Importance of bacteriology is being realized and most colleges are teaching courses in this important subject. Great stress should be given on the allied subjects related to the field of animal nutrition in addition to the chief importance that is laid upon animal nutrition itself.

It is necessary to provide the students a thorough understanding of the techniques of the skills that are needed by an animal nutritionist. Practical work should be greatly emphasized in all related fields. It is a matter of great concern to us that most colleges do not provide enough facilities for learning techniques for lack of technical personnel and equipment. Students should be given a chance to conduct nutritional experiments using small animals as well as large animals. The results of such trials should be analyzed statistically by students. This will give them sound ideas on planning the nutritional experiments. Above all they should also be given instruction in general learning areas which will provide them the wisdom for the solution of those problems with which all men are confronted as human beings.

3. SRI B. NARASIMHAM (Bapatla) : *Teaching Horticulture.*

The art of teaching, which exerts a lasting influence on the development of the country, is to be acquired by long experience. The administrative transfers of teachers into the general department in vogue in the Colleges run by Government is not conducive to efficient teaching.

Horticulture should be independent section in the College for adequate attention and since it consists of at least three unlike divisions, viz., fruits, vegetables and ornamental plants—there should be a separate lecturer for each of the subjects.

Post-graduate study and research facilities should be available at the Colleges and especially at the Indian Agricultural Research Institute for specialisation.

Should the students gain the necessary confidence to earn an independent living after graduation, the stress in Agricultural instruction in general and horticultural education in particular should be on the practicals rather than on theory. To this end, the examinations with their greater stress on written tests conducted during the brief period set for the purpose to be suitably modified.

The practicals should not be confined merely to the local practices but should include latest and advanced methods which are usually touched upon only in the theory classes.

The students should have opportunities of working on actual crop plants and not on shoots or mock plants to give them a sense of reality. What is taught in the class room has to be practised in the field in the institution. Conflicting professional opinions should be taught only after the students are thorough with one of them.

It should be desirable to allot more hours for field subjects like Horticulture in the first and second terms, i.e., in the busy season and the consequent reduction in laboratory classes is made up by having more of them in the last term. This gives the students a greater and more frequent touch with the plants.

A model set up is submitted for efficient handling of the subject.

It is essential that there should be periodical conferences of teachers of Agriculture subjects from all over India to discuss common problems, exchange views and make recommendations.

4. Sri P. GOVINDARAO (Bapatla): *The Teaching of Plant Pathology in the Agricultural Colleges.*

The author feels that there are a few lacunae in the teaching of Plant Pathology in the Colleges of Agriculture in India. A good and well written text book on plant pathology giving all details of the diseases occurring on the crops grown all over India seems to be the first need. It is suggested that the Head of the Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi might take up this work as he is in a position to know as to what is happening in India. The second need is for the creation of an agency to collect information about the availability of fungal forms in and round about all the Agricultural Colleges in India and arrange supplies either for cost or for exchange. The third need is the stress to be laid on the teaching of fundamentals in the Colleges. Growing of specimen diseased crops in the pot culture houses attached to the Institute or the College with the aid of the artificial infection in the laboratory and the systematic tours of students to places where epiphytotics are occurring and where disease control operations are being carried on, would impress the fundamentals on the student.

5. Dr. R. H. RICHHARIA (Sabour): *Teaching of Agriculture at the Bihar Agricultural College, Sabour—A scheme for the re-orientation of the system of practical training, as introduced.*

The reorganisation of agricultural education with special reference to giving more practical bias has been receiving active consideration of the agricultural educationists. As a first step, we have decided to intensify the practical training at the College within the bounds of the existing syllabus of the Bihar University but with a view to turning out soil-minded scientific farmers, capable of taking to Agricultural Industry after getting their degrees.

The central idea is to run the College Farm (200 acres) purely by the students under the management of the Agronomy group of the College. The students themselves would work where casual labour was previously employed. This will not only improve the agricultural training of the boys by giving them an overall idea about farm management and agricultural practices, including clear conception of the whole process, but also enable them to acquire practice and develop stamina for working out-doors at a stretch of 8 hours a day. This has necessitated re-planning of our daily established routine, reduction of holidays from 152 to 110 days (about 31 working weeks), re-arrangement of examinations and conducted tours.

According to this routine the students of one class (Year) will be at the Farm (The Bihar Agricultural College has a three-year course after I.Sc.), i.e. 70 boys will always be available at the Farm and the remaining two classes will be having theoretical lectures and laboratory practicals. The practical classes will include

Agronomy, Animal Husbandry, Veterinary, Horticulture, Rural Extension and Engineering and the Laboratory will include Botany, Entomology and Zoology, Chemistry and Mycology, besides theory classes in all subjects. In other words in every 3 weeks, each class will have one turn of one week at the Farm and two turns (of two weeks) in the class.

For the purpose of conducting field practicals and keeping in view the syllabus for courses of studies, 6 units have been formed at different parts of the Farm and practical work in which students will be working in batches of about 12 each, rotating from unit to unit after every two days during busy season and weekly otherwise.

The minimum percentage of lectures have been fixed as follows :—

In practical	75%
In Theory	67%

A sample of the weekly programme drawn up is reproduced below :—

"The following rotation will be followed for Field work of 1st year class for the week from 12th to 19th July, 1954."

Date	North Section	South Section	Godown Implement	Dairy & Poultry	Survey & Engineering	Miscellaneous & Estate
12-7-54	... 1	2	4	3	5	6
13-7-54	... 3	4	6	5	1	2
14-7-54	... 5	6	2	1	3	4
15-7-54	... 2	3	5	4	6	1
16-7-54	... 4	5	1	6	2	3
17-7-54	... 6	1	3	2	4	5

As regards records of the work done by each student, a field practical work card (system) has been evolved where daily progress, made by the student, is recorded and work reviewed by the Professor of Agronomy at the end of the week, which is then further scrutinised by the Principal.

A comparison, between the system of practical training and the system followed in the past, shows that we have increased the number of total working hours from 3126 to 4212. Whereas we have not undermined the importance of theoretical knowledge we have given weightage to practical farming.

To help the students to undertake long hours of strenuous work, certain amenities have been provided viz., free breakfast, free afternoon tea and refreshment and other facilities.

6. SRI A. C. PANDYA (Anand) : *Teaching of Agricultural Engineering.*

Agricultural Engineering is taught as one of the several subjects in Agricultural Colleges of the Indian Universities. Agricultural Engineering can be divided in the following branches : (1) Farm Power and Machinery, (2) Soil and Water conservation including Irrigation, (3) Farm Structures, (4) Rural Electrification, (5) Farm-produce processing and (6) Rural Water-supply and Sanitation. Syllabi of most of the Universities cover first three branches. Main topics involved are surveying, irrigation, soil erosion control and water conservation practices, farm drainage, farm engines and machines, and farm structures. Students have no background of engineering principles except elementary courses in Physics and Mathematics. Suggestions for modifications in existing syllabi of Physics, Mathematics and Agricultural Engineering and a proposed syllabus of Agricultural Engineering are given.

Approach to teaching Agricultural Engineering should not be mathematical but it should be taught with help of prototypes, models, drawings, and charts, and by carrying out tests. There should be greater emphasis on students doing things by themselves. There is a great need for text-books of Agricultural Engineering suitable to Indian students. Suggestions are made for post-graduate education for agricultural graduates in Agricultural Engineering.

7. DR. S. KRISHNAMURTHI (Annamalainagar) : *Productive Enterprise Projects and Other Aids for Teaching Agriculture in the Colleges.*

Agriculture is an art, an applied science and a method of making a living. All these three aspects emphasise the need for making teaching of agriculture as practical as possible. It is a general characteristic of the Indian Colleges of Agriculture that a large number of students in these colleges are drawn from the non-agricultural middle classes and therefore practical aids and projects such as "productive enterprise projects" and schemes to increase manipulative ability, are all required to make the teaching of agriculture more effective and to make the agricultural graduates practical agriculturists and practical scientists. "Productive enterprise projects" are projects of great importance in achieving practical efficiency in agriculture among the students. In such projects, the student has a degree of ownership of the plot of land assigned to him and he is allowed to earn money for himself. The central idea is to put him in the position of a farmer, make him undergo his difficulties, but also achieve rewards that the farmer obtains for the difficulties undergone by him. This gives the student a realistic idea of what farming means, and of what improved scientific methods can achieve. Such a scheme has been initiated for the students of agriculture at the Annamalai University.

Agricultural tours and excursions play no mean part in teaching of agriculture and widening the practical vision of agricultural students, but improvements are needed by way of preparations and study of objectives of the tours beforehand to get the maximum benefit out of such tours which normally cost much expenditure.

The paper deals also with the role of specimen crop area, implements' museum, table models of several agricultural equipments for teaching, general agricultural museum, charts, atlases, black and white photographs and colour photographs, and audio-visual aids in teaching of agriculture.

8. PROF. L. S. S. KUMAR (Poona) : *Agricultural Education—Its Present Scope and Future Development.*

Agricultural education in the Bombay State which began in the seventies of the last century has today been organised into a well developed course of instruction. Begun as a non-degree or licentiate course, it has passed through the phase of the diploma course and for the past several decades has reached the degree stage imparted at a level equal to that of any degree course of the University.

The aim of imparting agricultural education at higher levels has been to provide sound theoretical and practical training in agricultural science. The training given is both basic and comprehensive so that it enables the graduate to fit himself to work in any one of the branches of agricultural science with ease. Thus a well trained graduate is sufficiently capable of

1. giving sound advice on modern practices of agriculture to farmers in general,
2. managing and running successfully a farm attached to an agricultural industry,
3. farming on his own provided he has the land and the means to cultivate it, and
4. manning the state department of agriculture in either research, education or extension lines.

Thus among the several possible scopes or avenues of employment opened to an agricultural graduate the one that has provided more opportunities during the past decades and even today is the absorption by the state agricultural department. But the absorption by the state department cannot be in proportion to the number of graduates that pass out every year. Within the last decade the number of agricultural colleges in the Bombay State have increased from one to three and the total number of students admitted and trained as graduates have consiedrably increased. Since the scope offered for employment in the agricultural department is limited the graduates are seeking employment in other directions.

Until recent years the scope for employment of graduates in agricultural industries has been limited. Among the industries that have developed most is the sugar industry and this has absorbed a fair number of graduates. Other agricultural industrial concerns dealing in materials such as agricultural machinery and implements, fertilizers, and chemicals for crop protection have each provided employment for a certain number of graduates.

Contact with a few graduates has shown that some of them are working as farm managers of either private land owners or of new concerns started for promoting agricultural production of food and money crops.

The number of graduates who take to farming on their own are very few. The reason for this is that the students admitted to agricultural colleges largely belong to middle and lower middle classes, even though quite a few of them come from the farming communities. It is the lack of land and the finance that has handicapped many of them, otherwise willing, to farm on their own.

The agricultural graduate suffers from one great disadvantage which a graduate in medicine or engineering does not suffer from. Since there is very large demand for doctors, a graduate in medicane can set up private practice and can easily make a comfortable living. Similarly an engineering graduate can set up practice as a consulting engineer. A similar scope is not so readily available to an agricultural graduate to enable him to take to private farming or work as consultant. The present state of development of agriculture in the Bombay State or for that matter in the country in general, does not afford an agricultural graduate scope to work as consultant.

The overall picture of the scope for employment of agricultural graduates is thus far from satisfactory especially in view of the fact that a fair number of graduates still remain unemployed. These would be compelled to seek employment in professions other than agriculture, which would be entirely unrelated to their training.

The problem to be considered therefore is what is the place of agricultural graduates in the future set up of agricultural development in the country. Under the national development plan the need for well trained graduates is clearly indicated. In spite of this there are many qualified persons without employment. This would show that there is some flaw in estimating the requirement of graduates in agriculture which needs to be verified and corrected.

For the development of agriculture in the country and to make every citizen agriculture-minded it would be desirable that agriculture should be introduced as a subject in some form or other from the primary school stage upwards. If this is done it will promote two things. It will not only help to develop agriculture but will also open up an avenue of employment to agricultural graduates as teachers in primary and secondary schools. Graduates in agriculture could be given the requisite training as teachers before they are employed.

The widest scope for employment of agricultural graduates would be under the National Extension Service. The work of this service is vested in the Revenue department of the State. Only agricultural graduates can perform the function of National Extension Service in an efficient manner. Since this is an extensive service there appears to be scope for employing agricultural graduates in greater number.

It is not sufficient to employ agricultural graduates in National Extension Service only but it would be highly desirable to employ them in the revenue departments so that they could in time occupy posts of importance in the district administrative lines. Now-a-days Mamlatdars and Deputy Collectors are mostly graduates in Arts. If agricultural graduates are recruited for such posts and are given the requisite training in revenue administration they would make better officers because of their basic training in agriculture. It should be made a condition that every revenue and administrative officer should have a basic training in agriculture. This principle has already been accepted by Government and arrangements have been made to impart agricultural training to revenue officials. It is therefore evident that graduates in agriculture would make better revenue officers.

If those in authority could bring about the above change, it would make a difference to the standard of students seeking admission to agricultural colleges. Today as the scope for employment for graduates in agriculture is limited students of better calibre of intelligence seek admission into engineering, medical and science colleges and it is only the remnant that try for admission to agricultural colleges. Better chances of employment with an assured future leading to positions of responsibility will definitely attract intelligent students to take to agriculture. To begin with as an experimental measure if Govrnment would assure that twenty-five per cent of recruitment to the revenue department would be reserved for graduates in agriculture, it is bound to result in a change for the better.

It is also very necessary for graduates in agriculture to develop the trait to venture on their own, however disparaging the attempt may seem in the beginning. Organizing of pure seed and reliable fruit stock nurseries is a crying need of the land. Production of honey or poultry on a cottage industry scale, preparation of preserves and juices can all be done on a small scale without the need of much capital. It is only the bold and enterprising that can take to this line as it would demand a great deal of personal exertion and enterprise which is so much lacking in most agricultural graduates of today.

The lot of the agricultural graduates will be definitely better if they would learn the dignity of labour and do things with their own hands not merely while at the college but later on in life too. Further they should be ready to brave the uninviting conditions and the hard life of the villages. Since their services are required for changing these very conditions and the backward state of villages they should be ready to serve in villages where life is simple and inexpensive rather than flock into cities and put up with congestion and high cost of living merely because a few amenities are available. It should also be the endeavour of local administration to do all in their power to remove the disparity in living conditions and standards between village and town so as to make the village reasonably attractive for those whose standard of sanitation and clean living is too high to be willing to stay in villages. If this is done many more graduates would prefer to work in rural than urban areas. The shift of population from towns to rural areas would be desirable for the development of the latter and graduates in agriculture could lead the way in this matter by virtue of their training.

An important factor that acts as a deterrent to individuals in obtaining agricultural education and later on in following up agriculture as a profession is that of pay. Even under government service amongst all the technical branches the scales of pay in agricultural service, specially that of the upper subordinate service, is about the lowest compared to those of others. Considering the hard life and the difficult conditions under which an agricultural graduate has to work there should be better inducement and greater compensation given by way of better pay than what is paid at present. In practice the lot of the agricultural graduates who have to work in the open in the scorching sun or under other adverse weather conditions is quite dispiriting. The inequitableness of service conditions should be removed and an agricultural graduate should be paid on par with an engineering or medical graduate. If these disparities are removed and greater scope for employment as indicated above is provided there is a bright future for agricultural education which after all in any country forms the basis of all agricultural development and prosperity.

Section of Physiology

XXIV. TEACHING OF PHYSIOLOGY IN INDIA.

Chairman: Dr. N. N. Das (Calcutta)

1. Dr. S. BANERJEE (Calcutta).

Study of Physiology in India in the present days.

Physiology is taught in Indian Universities both in the graduate and post-graduate levels. Physiology is studied in all the medical colleges of India as a part of the First M.B.B.S. course. In some of the affiliated colleges of the University of Calcutta, physiology is taught as one of the subjects for the degree of Bachelor of Science. In the University College of Science and in the Presidency College, which is a constituent college, under the University of Calcutta physiology is studied in the B.Sc. course as an honours subject and in the post-graduate level in the M.Sc. class. Both in the B.Sc. honours and in the M.Sc. classes physiology is studied for a period of two years. In the medical colleges physiology is studied in the First M.B.B.S. course for a period of two years. Physiology includes studies on histology, experimental physiology and physiological chemistry (biochemistry). While in some of the medical colleges of India the studies in all the branches of physiology are co-ordinated by the professor of physiology in others it is not so. Histology is studied along with anatomy in some of the medical colleges. Physiological chemistry is taught by a professor or reader of biochemistry in some of the colleges and the department is independent of the department of physiology. In these colleges experimental physiological studies on amphibian, mammalian and human physiology are imparted in the department of physiology. In the First M.B.B.S. course chemistry is a subject for study along with physiology and anatomy in some of the colleges. In some of the colleges only organic chemistry is studied and questions on organic chemistry are asked in question paper on physiology in the First M.B.B.S. examination. In other colleges chemistry is taught in the First M.B.B.S. course but the students are not examined on the subject. Authorities of some of the colleges have decided to abolish the studies on chemistry as a part of the First M.B.B.S. course. They are of opinion that a knowledge of chemistry is not essential for a medical student. In the post-graduate level students who have passed the Final M.B.B.S. examination are examined in physiology under the Faculty of Medicine for the M.Sc. or M.D. degrees in some of the medical colleges. The student works on a problem under a professor of physiology and submits a thesis and if the thesis is recommended then the student sits for a written, practical and viva-voci examination. No theoretical or practical classes are held for teaching physiology in the post-graduate level and the candidate is left to itself for his studies. In some of the universities no syllabus is prescribed for the post-graduate course in physiology. Outside the medical colleges physiology is studied in the post-graduate level as a basic science only in the University of Calcutta in the Presidency College and in the University College of

Science. There is a prescribed course of syllabus both for the theoretical and practical papers and regular classes are held for two years. Students, however, do not have a knowledge of anatomy and some of the students are admitted in the course who do not pass B.Sc. with chemistry as one of the subjects.

PROBLEM OF STUDIES IN PHYSIOLOGY IN THE MEDICAL COLLEGES

Chemistry as a subject in the First M.B.B.S.

To explain the various physiological processes in the body, the knowledge of chemistry is essential. Without a basic knowledge of organic and physical chemistry it is not possible for a student of physiology to understand the subject in the proper perspective. Chemistry, therefore, should be one of the subject in the First M.B.B.S. course. Students should be examined in chemistry because no students read a subject in which they are not examined. Tendency of medical politicians of India to remove chemistry from the curriculum of the First M.B.B.S. course should be resisted by all physiologist. Otherwise teaching of physiology will suffer greatly.

Duration of course of studies in First M.B.B.S.

The Indian medical council is going to diminish the duration of the course of studies in the First M.B.B.S. from two years to one year and a half in order to produce more doctors in a short period of time. I had a discussion with many professors of physiology in medical colleges. All of them were of opinion that it is not possible to finish the course of studies in physiology before two years. Country needs more doctors no doubt but without a basic knowledge of physiology efficiency o fdoctors will suffer greatly and every body will agree that the country needs efficient doctors.

Teaching of biochemistry as a subject independent of physiology.

In some of the medical colleges non-medical men without a knowledge of physiology are appointed to teach physiological chemistry. As a teacher of physiology I fail to understand how such a person can be an efficient teacher on the subject. Any physiologist who has read organic chemistry in the B.Sc. can teach physiological chemistry. Physiological chemistry should not be separated from general physiology. To explain general physiological principles chemistry of the processes must be told at the same time. Different teachers may be entrusted to teach different systems of physiology but chemistry of the different systems should be taught along with the individual systems. The tendency to disintegrate the studies of physiology is harmful and this should be resisted by all the teachers of physiology.

Study of histology under anatomy.

Histology is being studied along with physiology. In some of the medical colleges histology is now under anatomy. Anatomists argue that histology is minute anatomy and as such should be taught under anatomy. There is no harm if students read histology along with anatomy. Teaching of histology will not suffer in the hands of an anatomist. Students in the First M.B.B.S. course spend more time in anatomy than in physiology. The only difficulty which the anatomists will face is the time table for taking both the morbid and minute anatomy classes.

Pay of lecturers and demonstrators in physiology.

Lecturers and demonstrators in physiology in the medical colleges are very poorly paid and as such they have to depend on their private medical practice for extra income. They, therefore, cannot devote whole-hearted attention to their duties in the department. Unlike other clinical departments of medical colleges and the prospect of these teachers to earn more money by private practice is not very bright. As a result this department does not attract usually doctors with a good academic career. The attention of the authorities of medical colleges is, therefore, drawn to this fact with a request to increase the emoluments of teachers and demonstrators in physiology.

Post-graduate studies in physiology under the faculty of medicine.

According to the rules of the Indian Medical Council a teacher in a medical institution must possess a post-graduate degree in the subject he will teach. Doctors, therefore, try to obtain the M.Sc. or M.D. degree in physiology to become a professor or a lecturer in the subject. No proper teaching, however, is imparted on the subject in any of the medical colleges in India. The professor guides the student for his thesis which forms a part of the examination and for the second part of the examination the candidate is left to himself. No syllabus is prescribed and as such the candidate does not know what to read. This is a very unhappy state of affairs. In some of the Universities there is no post-graduate degree in physiology under the faculty of medicine. In the university of Calcutta a person who has passed Final M.B.B.S. examination is not allowed to read M.Sc. in Physiology unless he passes B.Sc. with physiology. Doctors of the University of Calcutta are, therefore, at a disadvantage as compared to doctors of other Indian universities. The attention of authorities concerned is drawn to these problems with a view to remedy the defects at an early date. Professors of physiology are requested to influence the authorities concerned to evolve a unified syllabus for post-graduate studies in physiology so that a standard is maintained in all the universities of India.

Study of physiology outside the medical colleges.

It has been said that physiology is taught in B.Sc. and M.Sc. classes in the University of Calcutta as a basic science outside a medical institution. The B.Sc. honours standard is higher than the First M.B.B.S. standard in physiology. The M.Sc. course is extensive and different branches of physiology including biochemistry are taught at a higher level. Only defect of the course is that students do not disect a human body and do not read anatomy. If a paper on anatomy is included in the curriculum for M.Sc. the defect is rectified. As biochemistry is taught extensively along with physiology no student should be admitted in the course who does not pass B.Sc. with chemistry and physiology. In the B.Sc. human physiology should be one of the subjects for study along with anatomy. Students who will take up physiology, anatomy and chemistry in the B.Sc. should be admitted into the Final M.B.B.S. class after passing the B.Sc. examination. Physiology should be one of the subjects for the examination of the Indian Administrative Services. This will be an encouragement for students to take up physiology in the B.Sc. stage and authorities of colleges will open physiology departments for B.Sc. examination.

A few problems facing the teachers in physiology have been brought forward and some solutions have been suggested. I would request all the physiologists to consider the points raised and to evolve a solution in a better manner so that teaching of physiology is imparted in the best manner in the colleges, medical and non-medical, of India.

2. SRI P. B. SEN (Calcutta) : *The need of greater Orientation of Physiology with other basic Sciences.*

The science of physiology should receive a greater attention as a subject of general education; because it would help people to orient life to the changing patterns of social and physical environments. On this basis of general education, the physiologists may build up their specialized knowledge on the different aspects of the science. In such specialization, it is not desirable to limit the applicability of physiology, by adopting a narrow angle of vision. As an applied science, physiology would profit by a substancial knowledge in many of the basic sciences. We can hardly name any science which has no direct or indirect application in some aspects of physiology. We are also conscious that the problems of physiology has stimulated the development of other sister sciences. So in the brotherhood of sciences, physiology, is flourishing in a symbiotic coexistence. In the present stage of development, a physiologist is expected to know many sciences having appilcation in physiology. So after the study of basic physiological principles it may be necessary for one to specialize in one of the aspects of physiology. Thus a physiologist may fit himself in many of the applied branches, such as, environmental physiology, industrial physiology aviation physiology, comparative physiology, bacterial physiology, physiological chemistry, biophsics, pharmacodynamics, and many other allied branches of study.

3. DR. B. NARAYANA (Patna) : *Teaching of Physiology in India.*

The subject of Physiology can be taught either in the Faculty of Science as a purely science subject or it can be taught in the Faculty of Medicine as a part of the medical curriculum. In India Physiology is being taught almost exclusively in the various medical colleges and very few science college have provided for the teaching of Physiology leading to the B.Sc. or M.Sc. degree. A science student learns Physiology as a purely science subject whereas a medical student thinks more of its application to the study of medicine. It is necessary that even a medical student should study the subject on a purely scientific basis if he has the desire to apply the physiological principles in his medical practice.

Physiology embraces Histology, Bio-Chemistry and Bio-Physics. There has been a serious attempt to take Histology to Anatomy and put Bio-Chemistry as a separate subject. There is no harm in having a department of Bio-Chemistry independent of the department of Physiology but there should be co-ordination in the teaching of Physiology and Bio-Chemistry at the undergraduate level. In a Medical College the teaching of Histology may be done either in the Department of Anatomy or in the Department of Physiology but any step taken in this direction should be done with the consent of the two departments and in the best interest of the students. In a Science College the teaching of Histology should continue to be done in the department of Physiology.

A degree course in Physiology should normally cover 2 years whether in a Science or in a Medical College. Apart from the systematic lectures, there should be—(*a*) tutorial classes with as few students in a group as possible, (*b*) Conferences in which the whole class could participate and discuss special subjects under the guidance of a senior teacher, and (*c*) practical classes. The practical classes should comprise human and mammalian Physiology as well.

A B.Sc. degree course with Physiology as one of the subjects should be provided for in more institutions and arrangements should also be made so that a medical student could take a B.Sc. Honours degree in Physiology within 2 to 5 years of his admission to the Medical College. A B.Sc. Honours degree in Physiology should lead to a Master's degree in the subject obtainable either by pure research or by a combination of research and regular instructions in the subject followed by examination. A B.Sc. pass degree, on the other hand, should not lead to the

M.Sc. degree by pure research. In a Medical College, the teaching of Anatomy, Histology, Physiology, Bio-Chemistry and Bio-Physics should be integrated as far as possible and when this is done it is immaterial whether Histology is taught with Anatomy or Physiology and whether the Department of Bio-Chemistry is independent or a part of Physiology.

4. DR. S. K. DATTA (Calcutta): *Teaching of Physiology in India.*

Physiology is a highly complex science and it is applied in nature. Complete understanding of the life process is far beyond the limit of human knowledge.

Physiology was treated as one of the major subjects in the medical course. But its separate study with fundamental knowledge in other basic science is essential.

Physiology has not received proper appreciation due to many factors. Want of balance among teachings, researches, and the applications is keenly felt. Role of physiologists in the social life is also an important factor. Co-operation of the state for the development of this applied science will be helpful.

The change in the outlook of the teachers of physiology seems also to be required.

Proper application of physiology should provide suitable employments for young physiologists.

Progress of this applied science should help the development of India.

5. SRI J. N. MUKHERJEE (Calcutta):

In India, the subject of Physiology is being taught mainly in the medical curriculum and partly in the general scientific curriculum. The study of Medical Physiology is based on preliminary and general principles of the subject. The medical students do not think deeper into the fundamental growth of the subject. They may never have an opportunity to think further on this subject than to apply the crammed formulae.

On the contrary, Physiology as a basic science subject is being taught in such a way that the student is expected to find out newer facts which are still unrevealed. For this, there must be ample scope of study and research and encouragement to the students of this basic science subject.

It is unfortunate that in India, the authority is being influenced by the medical Physiologists who have a limited outlook on this subject.

I may put my appeal to the Physiologists of India that we should try to establish our own status so that we may not remain in the future as dolls in the hands of those medical men, otherwise the growing scientific spirit in the minds of Physiologists of India will be nipped in the bud.

I have experienced another difficulty amongst the B.Sc. students: they have very little idea of the macroscopical structure of the body. This problem may be solved by making a suitable arrangement with the medical college for the dissection of one body in three months time and setting one compulsory question on macroscopical anatomy in the University question paper.

I also express my earnest desire that a provision be made for the medical graduates to study the M.Sc. Physiology if they desire, without appearing for the B.Sc. examinations. Those medical graduates who are really keen to be Physiologists, must have this facility.

6. DR. J. D. PATHAK (Baroda):

The premedical curriculum should be so arranged that organic chemistry etc. has not to be repeated in the medical college. This would save a good amount of burden of the Physiology courses.

A co-ordinated course not only between the various disciplines of Physiology—biochemistry, nutrition, histology necessary but the course should be arranged and well co-ordinated with even the other departments—as anatomy. There is a great tendency to deal with the subject in a compartmental way. This is not correct. The human being should be considered as a whole. In teaching the various chapters, anatomists, pharmacologists, physicians and others should be brought in the same classroom to teach them speciality. Arrangements for symposia will not only impart the subject better but will save considerable amount of overlapping and what is more—the standard of teaching will considerably improve.

The teaching of Physiology should not end at the I M.B.B.S. examination. The students should be taught by Physiologists the various aspects of applied Physiology throughout the clinical years.

In the Medical Colleges greater emphasis needs to be paid on the clinical-medical aspect of the subject and it is a high time now that Human Physiology exercises should be introduced in the courses.

XXV. INTERRELATION OF PROTEIN AND VITAMINS.

Chairman : Dr. N. N. Das (Calcutta).

1. Dr. B. MUKERJI (Lucknow) :

Since the discovery of "yellow oxidation enzymes" by Warburg in 1932 and subsequent evidence that riboflavin is a component of this enzyme a new chapter has been opened up and lot of interests have been created in carrying out investigations to evaluate the relationship between vitamins and enzymes. These resulted in the further discovery that nicotinic acidamide, riboflavin and thiamin are the main components of a number of co-enzymes. These enzymes after combination with a specific protein or enzyme are capable of being alternately reduced and oxidised and in this way transference of hydrogen from a substrate to a final oxidising agent takes place. The nutritional effect of the vitamins already mentioned is directly related to their known roles in enzymic behaviour.

Since the vitamins maintain animal life, they may, as part of their action influence secretions of the organism. Thus a relation of vitamins to hormones though not *a priori* is not illogical. It can be generally observed that in animals which have been deprived of vitamins for a long period, not only the entire organism suffers but that particularly the glands loose vitality resulting in the decrease of the effective secretions.

In addition to the general effect of vitamins on the secretion of hormones, there has been synergism and antagonism of vitamins to hormones. Thus there is what has been interpreted as a synergism between vitamin C and the hormones of the adrenal medulla and cortex. An antagonism between Vitamin C and the thyroid hormone has been postulated. There are several interesting observations on the relationship of various vitamins and hormones of pancreas, thyroid, sex organs, parathyroid and adrenal glands, which will be discussed. Much ground remains to be covered in this field of study.

2. Dr. G. C. ESH (Calcutta) : *Protein metabolism and Vitamin B-complex with special reference to Vitamin* B_{12}.

For normal protein metabolism various B-complex vitamins are needed in adequate concentrations. Presumably these vitamins act in enzymatic fashions in promoting protein synthesis. Amino acids may be converted to vitamins. The outstanding example of this is tryptophan which can serve as precursor of niacin. The interconversion of methionine and choline under certain dietary conditions is too well known. Again the dietary intake of protein is a factor which influences the requirement and metabolism of certain members of the B-complex. Animals ingesting diets low in protein are incapable of retaining riboflavin and nicotinic acid efficiently and of maintaining tissue concentrations of them. The requirement of vitamin B_6 is increased when animals are fed high protein diets. Due to its lack tryptophan metabolism is deranged and an abnormal metabolite xanthurenic acid appears in the urine. Pantothenic acid deficiency is less readily induced when a high protein diet in contrast to a normal protein diet is given. Thus for the maintenance of normal tissue concentrations of the factors like vitamin B_2, niacin, biotin, folic acid, B_6 and pantothenic acid an adequate protein intake is necessary.

Both folic acid and vitamin B_{12} take part in protein utilization not only for hemopoiesis but also for growth and development. Experiments have been reported showing the influence of B_{12} in increasing the digestibility and biological value of casein and soyabean protein. Recently the author has observed in the Bengal Immunity Research Institute that vitamin B_{12} not only enhances the digestibility and biological value of vegetable proteins like pulse protein but it also significantly increases the growth promoting value of such proteins particularly when the animals are fed at high levels. Experiments with rats and chicks have indicated that B_{12} is concerned in transmethylation processes particularly those involving methionine formation. It has been suggested thereore, that B_{12} aids the methylation of homocysteine by promoting the synthesis of methyl groups available for use in the synthesis of methionine from homocystine. Thus animals can utilise certain amino acids (serine and glycine) as sources of the methyl group of methionine synthesis when B_{12} is supplied.

B_{12} is related to the genesis of nucleic acid in liver cells. The increase of PNA in the liver, spinal cord and cervical sympathetic ganglia after parenteral administration of B_{12} to deficient rats has been demonstrated. Plasma protein of B_{12} supplemented chicks was found significantly higher than that of deficient chicks. It seems possible that B_{12} functions in protein metabolism by stimulating formation of ribonucleoproteins and plasma proteins. Various experiments tend to indicate that B_{12} can decrease the loss of nitrogen resulting from the catabolic action of thyroxine. The results suggest that in hyperthyroid rats vitamin B_{12} spares protein at the expense of other body constituents. It is however, interesting to note that B_{12} has no influence on cortisone induced protein catabolism.

3. Sri P. B. SEN (Calcutta) : *The effect of high protein diet on the development of scurvy.*

Ascorbic acid has been found to play a considerable role in the protein metabolism, particularly in respect to the aromatic amino acids. Studies on the excretion of alpha amino nitrogen in urine suggests that other amino acids are also involved in the deficiency of vitamin C. In this condition, some of the enzymatic processes that are linked with protein metabolism are also directly or indirectly affected. Ammonia/urea ratio in urine is also increased during scurvy.

Level of protein in diet has some influence on all these factors and on the development of scurvy. The survival period of scorbutic guinea-pigs is diminished under heavy protein load, which is also associated with an appreciable increase in the excretion of vitamin C in urine. High level of protein in diet acts as a stressor, producing a marked hypertrophy of the adrenal gland. The adrenal ascorbic acid is relatively diminished in scorbutic animals, especially in those that are kept in high protein diet.

The basal oxygen consumption in guinea pigs is increased as the protein level in the diet is raised. This stimulus to the basal oxygen consumption is absent in scorbutic guinea pigs, where different patterns of fluctuations are observed during the progress ot scurvy, associated with high protein diet. The specific dynamic action of protein in different levels of intake is manifested by a characteristic pattern having a definite time lag.

4. Dr. P. S. SARMA (Madras) :

Two aspects of the fascinating study of Inter-relation of Vitamins and proteins will be presented, one dealing with the protein transformation during germination investigated with anti-vitamins and the other on the influence of protein hydrolysates on the biological synthesis of nicotinic acid from tryptophane. Dealing with the first aspect it is well known that during germination of seeds, there is a rapid breakdown of the reserve proteins into the constituent amino acids followed by synthesis of the protoplasmic proteins of plants. Our investigation with the antivitamin, neopyrithiamine has led to the establishment of a conversion of glutamic acid to aspartic acid and the participation of thiamine in these transformations in green gram (Phaseolus mungo) seedlings. Evidence has also been obtained for such participation by tracer technique by the use of radioactive glutamic acid and radioactive glucose.

In regard to the influence of proteins and protein hydrolysates, on tryptophane nicotinic acid inter-relationship, it was at first thought that the proteins like gelatin or casein or their hydrolysates influenced the intestinal flora of the animals and thereby altered the nicotinic acid requirement. Work in this department carried out with the nicotinic acid dependant strain of Neurospora Crassa, showed that the utilization of tryptophan, formyl kynurenine, kynurenine and 3-hydroxy kynurenine were affected when protein hydrolysates were present in medium and that the utilization of 3-hydroxy anthranilic acid and nicotinic acid were not at all affected. It was also observed that the activity of the enzyme 'Kynureninase' was depressed by protein hydrolysates as well as certain specific amino acids.

5. Dr. D. P. SADHU (Calcutta) :

Metabolism of proteins is controlled to a great extent by some vitamins, usually with the help of hormones. These vitamins form a part of the enzyme systems in general which mediate protein metabolism. Vitamin A forms a protein complex of rhodopsin and porphyropsin, necessary for normal visual functions. It also decreases Specific dynamic action of protein (SDA) indirectly by acting on thyroid. Vitamin E decreases creatinuria of children after glycine administration and has also a general regulatory influence on energy metabolism. Pyridoxine as pyridoxal or pyridoxamine phosphate acts as a co-transaminase and catalyses transamination reactions and thus reduces SDA, while its deficiency increases SDA (Sadhu). It also helps in decarboxylation of certain amino acids as a decarboxylase and mediates the conversion of tryptophan into nicotinic acid and N'-methyl-nicotinamide. It is also responsible for gluconeogenesis from amino acids.

6. Sri J. N. MUKHERJEE (Calcutta) : *Relation of Vitamin-E with the muscle dystrophy.*

The dystrophy of muscle have been observed in the animals, fed on vitamin-E deficient diet. Milman *et al*, have shown that loss of muscle protein in vit-E deficiency cannot be explained by an increase in the rate of breakdown of protein in the muscle.

I have observed *in-vitro* experiment that there is considerably low protein absorption in the isolated intestine from the vit-E deficient diet. This considerably low absorption of protein in the intestinal canal might be one of the factors responsible for the dystrophy of the muscle.

7. **Dr. S. N. Ray** (Izatnagar):

In guinea pigs, fed dessicated thyroid, the requirement of vitamin C for the preservation of tooth structure is thrice than that for control animals. In rats, dessicated thyroid feeding does not affect the ascorbic acid content of either liver or the suprarenals, but the content of the vitamin in the kidney is greatly reduced. It is suggested that heightened protein metabolism leads to large formation of ammonia which leaches out ascorbic acid from the kidneys. Increasing the body temperature by exposing animals to the direct sun light also leads to a lowering of vitamin C in the blood serum.

In cobalt deficient sheep the nitrogen balance is negative. When cobalt is administered, the balance becomes positive within a few days. As vitamin B_{12} injection alone can cure cobalt deficiency most probably this vitamin is concerned with effective protein utilization and storage.

8. **Dr. SHIVKUMAR** (Amritsar):

(1) Intimately related to the metabolism of Ribonucleo-proteins, the formation of Plasma proteins apart from its effect on myobuation of Haematopoieses, is agreed Cohalamine or Vitamin B_{12}. Some of its metabolic functions included, the utilization of one carbon compounds generation and transfer of methyl groups, and regeneration—S-S—groups into the function—SH groups of enzymes as in Acet Co enz. A etc., of the 'proliation' groups of glutathione (reduced. Vitamin B_{12} influences protein utilization and nitrogen retention. The protector influence of Proteins (containing SH-groups) and their influence on Haematopoiesis and protection of macrocytosis was discussed by the author in relation to his own work.

(2) Apart from its role in the fat metabolism the pyridoxal group of E-Vitamins (B_6) has its primary catalytic role in the metabolic reactions of aminoacids. It is now recognised that this group functions as a coenzyme in transamination reactions, desulphydration of Sulphur aminoacids, dehydration of hydroxy-amino-acids, decarboxylation of aminoacids, racemization of amino-acids, as a cofactor aminoacid reactions. Thus it would seem to be intimately related with metabolism and utilization of proteins and the constituent aminoacids.

(3) Indirectly related to the metabolism of Proteins, on account of its role in the transacetylation reactions and initiation of Wreh's tricarbocylic acid cycle—a source of energy—is the Pantothenic acid—SH group containing Acetyl coenzyme A. The antibody titre decreases in Pantothenic acid deficiency.

Section of Psychology and Educational Sciences

XXVI. PSYCHOLOGICAL RESEARCH IN INDIA—ITS PAST, PRESENT AND FUTURE.

Chairman: Dr. Raj Narain (Lucknow).

1. **Dr. PANDHARINATH PRABHU** (Bombay): *Current Psychological Research in India.*

A survey of the research recently completed and currently engaging the attention of psychologists in India is taken, and an analysis with a view to locating the general trends of such research is made. An attempt is made to find out if the causes of these trends are peculiar to Indian conditions. Some suggestions for new directions of research are also discussed.

2. Dr. (Mrs.) K. CHOWDHRY (Ahmedabad) : *Research in Industrial Psychology in India.*

In India it can be safely said that the use of Psychology in Industry started after World War II. Even now the use of psychologists is very limited in Industry, but there are indications of their being wanted in larger numbers by different industries.

The organisations doing research in the field of Industrial Psychology are very few. There are Applied Psychology sections of the Universities, Research Organisations connected with the Industry, and Personnel and Industrial Relations Departments of some individual firms.

In this paper a brief history of the development of Industrial Psychology in India and the broad scope of work being undertaken by some of the major Universities and individual firms are given. The main emphasis of the paper is on the development and the growth of the Psychology Department of the Ahmedabad Textile Industry's Research Association. The beginnings of the Department, the policies in the selection of research problems, the factors connected with the selection of research personnel in ATIRA as well as in the mills, the nature of implementation in the mills etc., are discussed. Research problems that have jointly been undertaken with Indian Council of Medical Research, Calcutta, the Social Research Institute of the University of Michigan, Ann Arbor, the Industrial Relations Department of MIT, and the I.L.O., Geneva, have also been discussed.

A brief account of Industrial Psychology work in Tata Industries in the Sarabhai concerns, in Ahmedabad and Bombay and in the Delhi Cloth Mills, has also been given.

3. (Mrs.) P. PHATAK (Baroda) :

The paper specially deals with psychological research in the field of Education in the State of Bombay.

Psychological research in India is a young child and has not much of solid history. Since about a decade and half the interest in psychological research is spreading fast.

Most of the workers at the initial stage were those who have studied in England. The work they did was either repetition of the same or similar experiments that they might have done or observed in England. To-day many students take up psychological research with the intention of getting some degree. A tendency is observed to apply the variety of tests published in English to Indian students. Some times the test is translated and adapted into a regional language. Similarly, a lack of sustained interest in a particular research through some binding force is also felt.

An attempt is made to show how even the comparatively culture free tests require proper study and modifications before accepting them for a particular environment.

4. Dr. K. C. MOOKERJEE (Calcutta) : *The role of Psychologist in the Treatment of Mentally-ill Persons.*

A properly trained psychologist can render most valuable service at all stages in the treatment of mentally-ill persons. Such of the services which have been recognised on all hands as most useful can be summarised as follows :—

1. In History taking—detailed history from psychological standpoint—should begin from early infancy and end with the first signs of mental break down—no period of life should be left unaccounted for—all relevant information should be patiently gathered.

2. In Investigation—psychometric tests—psychodiagnostic investigations so as to reveal the mental contents and the circumstances for the failure of normal adjustments.
3. In Treatment proper—can render valuable aid in the treatment itself by supplementing with psychological services of either supportive or analytic type—in certain types of mental disorders adjustments in the psychological plain is all that is needed to effect a cure.
4. In the task of rehabilitation, the role of clinical psychologist can be hardly over-emphasized. Being in possession of important knowledge concerning the mental make-up of the patient the psychologist can confidently proceed with the work of rebuilding the home environment to make it less trying and more congenial for the patient to live in.

5. Mr. S. M. MOHSIN: *Training of Psychologists as Scientists.*

A. *Planning the Courses of Studies*: Unnecessary duplication is generally found in the courses from one stage to another. This should be avoided. The undergraduate course should provide a broad-based training in the fundamentals of the science. The post-graduate and Honours courses should provide a more intensive and specialised training. The specialization is to be effected through the grouping of closely allied branches.

At every stage, the courses should be planned keeping in view their usefulness in future training or life.

B. *Teaching*: (*a*) The scientific status of psychology. The use of the laboratory in teaching theoretical psychology. The use of the clinic in teaching theoretical psychology. Need for greater stress on physiology and statistics. (*b*) Laboratory work. Its aim not mere mechanical performance of some stock experiments, but training in scientific method for conducting independently original investigation and research. Suggestions are made for materialising this objective.

6. Prof. V. K. KOTHURKAR (Poona): *Research in Social Psychology in India.*

According to O. L. Zangwill, Social Psychology is still largely 'a hope of a science– a dream—rather than an accomplished fact'. Any way, it has had a very brief history abroad and briefer still in India, though it promises to have a great future. The impact of Independence and the terrific out-break of the post-partition hostilities together with their aftermath viz. vast numbers of displaced persons roaming over the land, brought home to our people and our Government the existence of vast areas of acute social tensions and the most violent forms of communal prejudice. It was in this context that research in Social Psychology in India had its brilliant beginning in 1950 with our Government requesting Dr. Gardner Murphy to plan and organize research in social tensions in the various parts of our country. Indian participation in the UNESCO Tensions Project. Work of the six official and some non-official research teams on the three cornered hostilities between Hindus, Hindu refugees and Muslims, together with the intricate pattern of caste-prejudices.

Two-fold radiation effect of the original research impulse and activity: 1. Not only a few active, continuing, creative centres of social research were established, but, other centres were presently drawn into the movement so that Psychology Departments nearly all over the country started functioning along this line. 2. Secondly, the techniques and methods tested and tried out in the field of group prejudice, hostility and general tension research are being adapted and applied to other larger areas like rural research. This is a healthy tendency in an agricultural country like ours and may result in an accumulation of a sizable body of knowledge regarding the procedure and principles of rural Psychology. Periodic publications of the Programme Evaluation Organization of the Planning

Commission like "Group Dynamics in a North-Indian Village—A study of factions" by Oscar Lewis (1954) or "Community Projects—First Reactions" (August 1954) are worth mentioning.

Statistical analysis of published and unpublished research papers in social Psychology in India. Inadequate facilities for reporting the results.

The general tendency of these papers is to give a surface description of some of our backward tribes (in the Anthropological approach) or to give the bare content of prevailing stereotypes, rumours etc. (in the psychological approach).

More significant research in Social Psychology in India must, in future, take the line of deeper dynamic analysis, interpretation and explanation of group behaviour and social relations.

7. Mr. ABDUL HAFEEZ (Mysore) : *Research in Experimental Psychology in the Mysore Laboratory.*

The laboratory was started in the year 1924 with Dr. M. V. Gopalaswamy, B.A., B.Sc. (Lond.), Ph.D. (Lond.), as Professor. He conducted and directed research of his students and associates on a number of topics including Child Psychology, Experimental Aesthetics, Crime, Intelligence, Personality, Values and Para-Psychology.

Dr. B. Kuppuswami, M.A., D.Litt., Professor of Psychology (Mysore) did research on the "Inheritance of habits" and has been constantly contributing a series of papers to the various journals and other learned bodies on topics like Intelligence, Child Behaviour, Group tensions, and Rorschach. Researches carried out in this laboratory among others include the following :—

1. A Study of Juvenile offenders.
2. Speed of Correlate Education.
3. Estimation of Character and Personality through P.G.R.
4. A study of twin resemblances and differences.
5. The development of fear, anger and laughter in Children.
6. The Psychogalvanic technique of Crime Detection.
7. Personality Types.
8. Psychology from the standpoint of Sri Sankara.
9. An experimental study of the Development of sense of values.
10. Measurement of Psychic Energy.
11. Psychokinesis.
12. Language Development of the Preschool Child.

8. Dr. D. MISRA (Parlakimedi) : *Relation between Philosophy and Psychology.*

1. The emancipation of Psychology from Philosophy has to be accepted as a fact; what is necessary is a change of attitude.

2. Psychological problems in the various phases of organic behaviour have to be approached strictly from the scientific point of view; no more of speculation.

3. Experimental approach—prerequisites of some training in Physics, Chemistry and General Biology have to be satisfied; a bit of Physiology and Biochemistry do constitute parts of Psychology; Mathematics essential for Statistics and computation of experimental data ought to be there also.

4. Considering the special problems of this country, particularly lack of statistical data with regard to intelligence and aptitudes, Statistics in Psychology and Education ought to be compulsory for every student of Psychology and for the advanced students of education.

5. Psycho-technological branches in the light of the growing industrialisation of the country should be opened in every university and courses in Vocational counselling and guidance ought to be provided in every training college with pro-

vision for the appointment of a vocational counsellor in every high school (more details to be discussed).

6. Provision of a comprehensive training at the Intermediate and the Degree stages (more details about the courses of studies to be discussed).

7. History of Psychology or Systematic Psychology should be a brief course at the Degree and a more comprehensive course at the post-graduate stage.

8. Introduction of Animal Laboratories (reasons for this to be discussed in detail).

9. Completely autonomous departments of Psychology in Colleges and Universities with all that a department requires (details of organisation and administration to be discussed).

Discussions will include the necessity for a change of attitude, the psychological attitude, courses of studies, different levels of departmental organisation and administration, teachers, prerequisites to be satisfied by the students, specific problems, which we have not yet approached, and which are arising as a result of the gradual industrialisation, reorganisation of Training Colleges, teaching of Education as a subject on psychological lines, psychological research and laboratory organisation and above all development of Psycho-technology in the application of Psychology to industry, medicine and problems of social upliftment.

XXVII. CRIME AND SOCIETY.

Chairman: DR. RAJ NARAIN (Lucknow).

1. DR. NIROD MUKERJI (Gauhati):

'Delinquency is not a social science concept but essentially a legal one'. Nevertheless its intricate bearing on the psychosocial aspects of the man makes it an important subject for closer scrutiny. The disproportionate rise in the delinquency, particularly among the juveniles, in almost all the civilized countries in the recent days impels us to seek for the causative factors more closely. Owing to the fact that foundation of the schema of personality is laid down during the early life of the individual, juvenile delinquency would naturally occupy a larger sector in any such study. That is why this paper mainly deals with delinquency during the preadolescent stage.

It is now generally admitted that any investigation on this subject to be fruitful should seek for the aetiological factors in the social sphere. An attempt therefore has been made in the present paper to determine some of the positively determining factors in the young delinquents, facts regarding which have lately been collected by the police of the district of Calcutta. Unemployment among the ablebodied youth, when it is desirous of keeping itself engaged in fulfilling social obligations appears to be one factor which needs be heavily underlined in pointing to the manifold causative factors.

2. DR. R. C. NIGAM (Jaipur): *Crime and Society in Ancient India.*

In this paper it is proposed to study only one aspect of crime in the Ancient Indian Society, viz., principles of administration of Criminal Law.

The Criminal Law of a nation is a mirror or true index of its culture and civilisation. The principles of administration of Criminal Law in Ancient India will, therefore, give us an insight into the civilisation and culture of the Ancient Indian Society.

(a) *Sources.*

The sources of our study are very meagre and are hardly to be found in written records until we come to *Arthsastra* of *Kautilya*, *Manusmriti* and *Yajnavalkya-smriti*, which cover, more or less, six centuries of Ancient India, viz., 300 B.C. to 300 A.D. This paper is mostly based on the above three leading Law Codes of Ancient India.

(b) *Danda or Punishment.*

The foremost duty of the King in Ancient India was to protect his subjects and to see that the rules of *Varnashrama Dharma* or the established order of Society were obeyed by his subjects and to punish the wicked and to dispense justice. The King carried out his duty through *Danda* or punishment, which was deified or personified as the Ruler in o rder to stress its deterrent force.

(c) *Purpose of Punishment.*

The purpose of punishment was primarily deterrent, while prevention, correction and purification occupied only a secondary place. But it was not retaliatory as *Jus Talionis* was not known to the Hindu penologist.

(d) *Principle of Individualisation of Punishment.*

The Hindus law-givers knew full well that the true measure of punishment depended on the nature of the crime, its magnitude, the character, status, education, in short, the individuality of the offender, as also upon the status of the injured and the value of the thing offended against.

(e) *Principles of detection and prevention of crime.*

The ancient Hindu administrators had an organised police system and had fully developed Criminal Investigation Department. They had developed elaborate principles for the detection of various offences and had also prescribed preventive measures in order to maintain peace and order in the Society. Persons were apprehended on suspicion of being notorious bad characters or having no ostensible means of livelihood. Nobody could sell or purchase second-hand articles without the sanction of the district authorities. Curfew was clamped at night time to prevent commission of offences.

(f) *Prerogative of Pardon.*

The King had the prerogative to grant pardon, reprieve or remission of punishment to the prisoners except those convicted of *Sahasa* offences and habitual offenders.

All the aforesaid principles of administration of Criminal Law are well borne out by the texts of the leading Law Codes of Ancient India. Such a coherent, scientific and systematic Criminal Law necessarily presupposes the existence of a well organised Society.

3. PROF. NIRMAL KUMAR BOSE (Calcutta) :

The concept of crime in any society is relative to the values which exist in that society. Ideas about property, about the ideals of sexual behaviour differ widely from tribe to tribe, and when there is a breach, the emotional reaction against transgression may also vary widely from one group to another. On a comparison between different civilization, we fail to reach any common elements in regard to the concept of crime all through the world. As has been said, it is relative to the values current in a society at any given point of time.

In regard to a single cultural group, the concept of right or wrong may also vary widely from one point of time to another.

When a social group is changing over from one economic or ideological condition into another, certain acts which might have been looked upon with disapproval may gain approval in course of time. What was formerly considered sinful might be regarded as criminal in course of time, and even that sting might be lost when the values of the particular society change still further.

Under these circumstances, any individual who deviates from the pattern of behaviour set for the time being, should be looked upon with greater personal consideration; because of the fact that our concept of crime is itself subject to constant change.

SCIENCE AND ITS SOCIAL RELATIONS

Being two lectures delivered by J. M. Sen in December 1954 in the University of Calcutta and which formed the basis of a Symposium held at Baroda Session of the Indian Science Congress on 7th January, 1955.*

The subject 'Science and Its Social Relations' is a vast one and it is not possible for me to deal adequately with many aspects of the application of science for the betterment of the humanity. I therefore propose to give a brief resumê of the subject as it appears to me relevant for a discussion.

In December 1943, Sir J. C. Ghosh in his address to the National Institute of Sciences of India at Delhi, stated—"Men of science by training and instinct are averse to wasting their breath over might-have-beens; it is the present and the future that interest them more than past". Indeed this is true. The scientists who discovered Penicillin and anti-biotics or the insecticides like the D.D.T., the biochemists who synthesised Hormones, the engineers who discovered the structural applications of magnesium alloys particularly in aircraft, portable equipment and tools, the scientists who contributed their quota to the human progress by use of electronic devices to which we owe modern telegraphy, wireless, television, radio location, talking pictures, picture transmission by wire and wireless, the scientists who analysed and synthesised proteins and gave a new interpretation as regards the machineries of life, and those modern alchemists who discovered tools for smashing atoms and for use of atomic energy, are men who understood the needs of the present generation of human beings and they gave a new value to the life and social well-being of the community as a whole.

Science, ever since the time of the Arabs, has had two functions: (1) to enable us to know things, and (2) to enable us to do things. The Greeks, with the exception of Archimedes, were only interested in the first of these. They had much curiosity about the world, but, since civilized people lived comfortably on slave labour, they had no interest in technique. The Arabs wished to discover the philosopher's stone, the elixir of life—they discovered many facts in chemistry, but they did not arrive at any valid and important general laws and their technique remained elementary. In the late middle ages two discoveries were made which had a profound importance; they were the mariner's compass and gunpowder. It is not known who made these discoveries. The mariner's compass made possible the age of discovery. The New World was opened; the route to East round the Cape of Good Hope made possible the conquest of India, and brought important contacts between Europe and China. The importance of sea power was enormously increased, and through sea power Western Europe came to dominate the world. It is only in the present century that this domination has come to an end. Nothing of equal importance occurred in the way of new scientific technique until the age of steam and industrial revolution. The discovery of gunpowder which is now used for blasting rocks and hard substances while constructing roads and tunnels, enabled men for years in subduing rebellions and in waging wars practically all over the world. It has also created the terrible problems of our time, viz. *war, technology in preparation for war, and nationalism* in almost all countries of the world.

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* Taraprosad Khaitan Lectures.

In his Rushton Lectures on "Education and World Tragedy" Dean Howard Jones has tried to show how far the present system of education has created the above mentioned terrible problems of our time. Retaining the normal idealism of western civilization as a standard of measurement, if any human being tries to discover what has happened to mankind in the last fifty years such a person would be overwhelmed by a single tragic conviction; namely that the history of mankind for the last half century has been a history of deepening horror. The first half of the twentieth century is over. And what do we find? Since 1899, the earth has scarcely known a year without warfare, armed revolt, massacre, pogrom or other ingenious form of slaughter. These fifty years include two infernal conflicts—World War I and World War II. They include such disastrous struggles as the Boer War of 1899-1902, the Russo-Japanese War of 1904-05, the two Balkan Wars of 1912-13, the innumerable wars, revolts, 'interventions' and massacres in Finland, the Caucasus, the Ukraine, Poland, Hungary, Manchuria, Siberia, and other border areas, which followed the Bolshevik Revolution of 1917. They include the long drawn out agony of China, which beginning with the massacre of garrison troops in 1917, continued till 1949. They include the intermittent civil war in Spain. These are the major events.

But there are the other episodes, tragic in their time, viz. the Cretan massacre during the last two years of the nineteenth century (1899-1900), when the Christians slaughtered the Moslem peasantry; the Boxer rebellion of 1900; the Phillipine insurrection and the 'water-cure'; the massacre of a million Armenians between 1899 and 1919. The year 1922 saw the Irish Civil War in full swing, and there were Black and Tan outrages. The year opened with the slaughter of Greek civilians in Samsun—more than one hundred thousand Greeks had been killed and the climax of 1922 was reached at the taking of Smyrna, when an estimated 200,000 Christians were rendered homeless and the city was given over to pillage, rapine, massacre and fire. There was an earlier Graeco-Turkish war in 1897-98, and an Italo-Turkish war in 1911. Between 1928 and 1935, Bolivia and Paraguay fought to exhaustion over the possession of a tropical jungle. Indeed, during most of these fifty years there have been rebellions in Latin America.

The half century has seen armed rebellion sweep through such famous capitals as Paris, Berlin, Madrid, Athens and Rome. It has seen more or less protracted revolutionary struggles in Russia, Mexico, Spain, France, Germany, Hungary, Austria, Greece, Egypt, Iran, Palestine and other Arabian States, Mongolia, China and various other countries, besides what uncounted minor uprisings—in Nicaragua, Haiti, Albania, Thailand and the like—only the World Almanac tells us. India has experienced a full blast of atrocities in Calcutta and Noakhali in 1946, throughout the Punjab in 1947, and in Kashmir in 1948. Ours is a sick age.

How many human beings have been killed directly or indirectly in the course of this terrible history? It is almost impossible to find out. For example, we do not know and probably shall never know how many hundreds of thousands have died of violence in Asia and Africa during the last fifty years. How many perished during the obscure struggle for the control of Tannu-Tuwa, a country as big as Great Britain, lying between Mongolia and Siberia? How many Koreans were slaughtered by their Japanese overlords? How many natives of Congo died during the struggle for the control of the Belgian Congo? We do not know how many hundreds of thousands died in Russia, or in neighbouring states during the terrible convulsions that swept over the future Soviet Union between 1914 and the adoption of the constitution of

1915. We do not know how many millions Hitler and his agents killed.—But what we know with rough accuracy is sufficiently appalling.

Before 1900, about 25 per cent of all battle casualties died; in World War I this increased to 33⅓ per cent. Out of every thousand Europeans alive in the twelfth century it is thought that two died as battle casualties; in the first twenty-five years of the twentieth century 54 out of every thousand so died. Professor Pitirim Sorokin estimates that during the first third of the twentieth century Europe alone suffered 24 million war casualties. From the eleventh century to the end of the nineteenth century war casualties totalled about 18 million. Therefore in the first three decades of the present century 33⅓ per cent more human beings were killed in war in Europe than were killed in the previous 800 years. These figures do not include four other continents and they take us only to the rise of Hitler. Influenza, typhus, starvation, and other destroying agencies killed millions more. It has been estimated that 40 million of world population died, directly or indirectly, in World War I. We do not yet know the figures for World War II. The Japanese dead alone are reckoned at more than three million. The science reporter of the New York Times was thought in 1945, to have written a singularly effective masterpiece about the rare beauty of the atomic bomb upheaval over Hiroshima. This killed or mutilated 150,000 human beings, 30,000 so completed that no trace of them remains. A United Press dispatch from the Vatican in November 1945, estimated the dead, military and civilian, in World War II at over 22 million, and the wounded at 34 million, *i.e.* 56 million casualties in all.

While this blind struggle continues it increases its ferocity. Through the mouth of Satan in *The Mysterious Stranger,* Mark Twain sardonically remarks, "No brute ever does a cruel thing—that is the monopoly of those with the Moral Sense." Millions (nearly 100 million) who died, directly or indirectly in the two World Wars are at peace. Unnumbered thousands of human beings whose lives have been wrecked by war or starvation or despair or disease still exist. Regarding the long range results of war upon our lives Professor Quincy Wright tells us :—"Closely related to the racial (*i.e.* human) cost of war but less susceptible to objective measurement are the social and cultural costs of war in the deterioration of standards. Wars of large magnitude have been followed by anti-intellectual movements in art, literature and philosophy; by waves of crime, sexual license, suicide, venereal disease, delinquent youth; by class, racial and religious intolerance; by persecution, refugees, social and political revolution; by abandonment of orderly processes for settling disputes and changing law; and by a decline in respect for international law and treaties." The standards of only a few, he says, are elevated by war, a minor gain which by contrast deepens the gloom of the general picture. The coarsening effects upon our finer sensibilities of an uninterrupted series of wars, revolutions and bloodsheds have been such that people merely read them as ordinary news in the newspapers and then turn to the sports pages. So deep have we descended into the pit of insensibility that Dr. Irving Langmuir, Nobel Prize winner, physical chemist and associate Director of the General Electric Research Laboratories, solemnly warned a joint meeting of the American Philosophical Society and the National Academy of Sciences in the autumn of 1945 in Philadelphia that "so-called atomic warfare, unless the release of nuclear energy is controlled by the world, may make the entire earth uninhabitable wiping out the ignoble race of men." Dr. Langmuir is a conservative scientist. He spoke sadly and seriously. But the Americans do not believe things like this because they, and possibly people all over the world, do not wish to believe them.

Dr. Langmuir's statement suggests a second basic fact in this brutal history. It is that *modern warfare is increasingly a function of education,* and education is increasingly dominated by war. We do not like to think that this is so. We try desperately to deceive ourselves. One form of optimistic rationalization is the "progress" fallacy. The progress fallacy assumes that mankind always survives any conceivable weapon. Another fact to be observed in this strange, eventful history is to note how nationalism increasingly invades education. The eighteenth century was perhaps the last period when a truly international culture was the common object of study, at least among the cultivated classes in the western world. Till then education was not customarily created or paid for by the state. Throughout the nineteenth century, and increasingly in the tweneith, the doctrine that education is a proper charge against the public purse has meant that the state, in greater and greater degree, has made education the instrument of its own support. The nationalism which this type of education has created has in its turn created an age in which instruments of communication have prematurely thrown cultures into collision with each other before the people were ready to understand one another. This nationalism, which has rallied religion, culture, technology and science itself to its support, now includes education—and it is a necessary part of something called 'national defense'. War, technology in preparation for war, and nationalism—these are three great forces warping the healthy development of education in what we call the civilized world. The problems they raise are deeper and darker than those polite fictions discussed in most educational meetings.

Face to face with the spectre of war, with technology controlled by war, and with an intense and irrational nationalism which, as in the case of atom bomb, dreams of going to war before some other nation shall invent an even more terrible weapon—and this, in a world in which the nations have solemnly pledged themselves to unite for peace—what have the scientists to offer for the guiding of mankind? Our problem is then deeper, more radical, and alas more nearly insoluble than a simple balancing of general gains in health, longevity, good will and control of nature against the stupendous losses of war.

Lord Bertrand Russel, the great English philosopher, in discussing the possibilities of the second half of the twentieth century, which he warns, may bring appalling disasters, says that "dislike of the Soviet system while it justifies us in resisting its forcible extension, does not justify us in going to war to change it where it exists. Our policy must not be that of crusaders, but of nations engaged in collective self-defence. And not merely self-defence, but defence of a way of life that we value. War, even if it were quickly successful, would damage this way of life; we should, when it was over, be less civilized, less humane, less capable of democracy, and less able to carry on the work of art and literature. War for civilization may sometimes be necessary, but civilization is not as good after a serious war as it was before. As guardians of certain things that we value, it is, therefore as much our duty to preserve peace if we can as it is to fight if we must."

Science is one of those human activities which have undergone a change of purpose or, at least, have come to serve different purposes, in the course of their development. Disinterested curiosity has been the great motive power of scientific research. Of the great "values" that condition our activities and make our lives worth living, viz. Goodness, Beauty and Truth, Science has been chiefly concerned with Truth. But "truth" does not seem to be a simple and unambiguous concept. We hear of "higher truths" and "deeper truths". We may ask then, 'What sort of truth is science after? In what sense is a true scientific statement true?' Some confusion no doubt arises. The criticism has indeed been made that science pays for its success by its superficiality. It has been pointed out that all the deepest problems of mankind lie outside science. If neither philosophy nor religion can present any such "body of tested knowledge", it is because they have not been content with such cheap victories. There is doubtless some truth in this criticism, and it is probably true that the problems with which science deals are intrinsically inferior in human interest to those dealt with by either philosophy or religion.

Nevertheless, the actual atmosphere of science, the manner in which it goes about its work, is quite exceptionally agreeable. It is in the scientific attitude, as much as in the scientific results, that the true value of science is to be found.

If the man of science has not aimed high according to the philosopher, he has at least aimed with a single heart, with a docility in face of the facts, with an impersonal purpose to serve which is not always found amongst our philosophers, and which is almost impossible to find elsewhere. Hence the scientists are among the greatest benefactors of the society.

Professor Elton Mayo in his book, *The Social Problems of an Industrial Civilization*, writes :—"Technical skill manifests itself as a capacity to manipulate things in the service of human purposes. Social skill shows itself as a capacity to receive communications from others and to respond to the attitudes and ideas of others in such fashion as to promote congenial participation in a common task. In these days, education has gone over—often extravagantly—to the development of technical skills and the appropriate scientific bases for such skills. This would be excellent were it not for the fact that the universities have failed to develop an equivalent study of and instruction in social skill. We have in fact passed beyond that stage of human organization in which effective communication and collaboration were secured by established routines of relationship.

AGAIN :

We have undertaken to transform an economy of scarcity into an economy of abundance, and the technicians are showing us the way. We are committed to the development of a high human adaptability that has not characterized any known human society in the past, and it is our present failure in this respect that finds reflection in the social chaos which is destroying civilised society.

AND AGAIN :

Under the influence of economic theory, we have a system of education that trains youngmen in technical understanding and technical skill : we do nothing whatever to develop social insight or to impart social skill. Indeed we provide an education that operates to hinder the development of such skills. And the general public, business leaders, and politicians are left with the implication that mankind is an unorganized rabble upon which order must be imposed. It was this delusion that encouraged Hitler's dreams of grandeur.

FINALLY :

We have failed to train students in the study of social situation; we have thought that first-class technical training was sufficient in a modern and mechanical age. As a consequent we may be sometimes technically competent, but we combine this with utter social incompetence. This defect of education and administration has of recent years become a menace to the whole future of civilization."

Professor Northrop also emphasizes the above opinion of Professor Mayo in his book, *The Meeting of East and West*, and says that the present civilization must re-educate itself or perish. The creation in the United Nations pattern of UNESCO—the United Nations Educational Scientific and Cultural Organisation—is a crowning example of world-wide interest in the inter-relations between war, technological training for war and nationalism on the one hand, and education on the other. Education is, then a world-wide problem. The catastrophes of the last half century have affected some parts of educational system in different parts of the world. Nevertheless, it is roughly true that primary education in most countries particularly in India has not been violently altered. Our sociological theories, our political economy, and our doctrines of education are derived from an unbroken tradition of the country. The whole of this tradition is wrapped by the vicious assumption that each generation will substantially live amid the conditions governing the lives of the fathers and will transmit those conditions to mould with equal force the lives of its children. For the first time we are beginning to realize that we are living in a period of human history for which this assumption is false. To express doubt concerning the timeless validity of tradition may shock the academic mind in India but it is nevertheless true that unless a re-orientation takes place in the traditional ideas of education there will be a disaster in the second half of the twentieth century both in social and political life of the country. The troubles lie, not with the education, but with human beings who will not live in the glory and wisdom of the tradition. Therefore the tradition must be re-taught. An attempt towards this direction is now being made by the Government of India, Ministry of Education, by inviting the attention of the public to a pamphlet on Basic and Social Education which seeks to provide a short account of what has been and is proposed to be done in the immediate future.

The discovery of murderous potentialities in nuclear energy and the invention of many death-dealing machines require that education in India must somehow take account of events in a world in which the U.S.A. and Soviet Russia have become dominant powers.—The whole of Asia is violently disturbed and man's uneasiness about his traditional values has spread from a few troubled spirits at the top of the social pyramid down among the mass of mankind everywhere. Merely to reafirm past values by a return upon dead sages will not quite do. What we need is an educational programme that will face the present with courage and interest. One difficulty with educational programmes is that they are never built for time but are always built for eternity. Each pedagogical reformer, convinced that he has found at last a changeless and enduring way of educating human nature, announces his programme as a series of timeless absolutes. Every curriculum has an air of being built upon he impregnable rock of holy scripture; and, since academic institutions are highly conservative, the new curriculum, once alive and vital, when it becomes moribund, either changes slowly or changes not at all.

It is not necessary to launch another educational reform. What is needed is a reorientation of scientific studies in colleges, so that full implication of the *Social Function of Science* can be understood in terms of

(*a*) study of the theory of science and of the application of scientific discoveries to technology, and

(*b*) A study of the personal relationships in modern society.

Regarding item (*a*), it may be said that professional, vocational, technical or technological training is unavoidable in a fiercely competitive democracy. The problem is not to deny its necessity but to control and guide its force. The problem is to bring our social engineering up to the maturity of our technological engineering. A course in 'General Science', a course in the history of science, a course in the postulates of the scientific method will merely increase our technological confusion unless it is joined to something else. That something else is the study of what happens to scientific discoveries when they are practically put to work in our industrial culture. Economist and sociologist, psychologist and anthropologist must join the scientist and point out that when science invents the internal combustion engine, vast economic and sociological forces are set to work. It is insufficient to praise research for its own sake. The tremendous (and sometimes tragic) results of research for its own sake, when these results take the form of widespread technological changes in modern society, are as basic to an understanding of the modern world as any part of scientific theory. The creation of instructional units of this sort will be a matter of great difficulty, but to keep scientific theory in one compartment and economic and social studies of a technological culture in another compartment is precisely the tragic error of our education and of our culture.

Regarding item (*b*)—a study of personal relationships in modern society—it may be said that this is not a subject whose elements can be so specific as the elements of general education previously suggested. Still the need of restoring confidence in the relations between man and man is supreme. Perhaps, in a fiercely competitive society, confidence in these relations cannot be wholly restored but the present corruption of these relations can certainly be checked and the conditions improved. To repeat Professor Mayo's words: "We have passed beyond that stage of human organization in which effective communication and collaboration were secured by established routines of relationship." Professor Mayo rightly charges the present governments with "utter social incompetence." *But the beginning of social competence is the trust of man in man;* and a wider understanding of the psychology of personal relationships seems to scientists a more desperate need in our education than polite courses in literature, philosophy and the fine arts.

A combination of all the aspects mentioned above will necessarily create a demand for laying down certain principles of a Charter for Scientists. And this was exactly what the Committee on Science and its Social Relations instituted by the International Council of Scientific Unions at its meeting held at the UNESCO House, Paris, did on the 15th and 16th June 1948. The principles of a Charter for Scientists which the Committee has drawn up can be summarised in the following sentences :—

The prominent position held at present by science in society, and the rapid transformation of the world through the application of science, carry with them for scientific workers special obligations over and above the ordinary duties of citizenship. Besides this the scientific worker has special responsibilities since he or she has the possibility of obtaining information not readily available to the average citizen. It thus becomes the duty of the scientist to:

(*a*) maintain a spirit of frankness, honesty, integrity and co-operation, and to work for international understanding;
(*b*) consciously examine the measuring and purposes of the work that he or she is performing;
(*c*) when in the service of others enquire into the purpose for which the work is being done and the moral issues that may be involved;
(*d*) promote the development of science in the way most beneficial to mankind and exert his or her influence as far as possible to prevent its misuse;
(*e*) assist in the education of the people and the Government in the purposes and achievements of science.

In order to fulfill these obligations it is necessary to claim certain rights for scientists, the principal ones of which are:

(*i*) freedom of publications and the utmost freedom to discuss one's work with other scientists;
(*ii*) economic security and the right to participate freely in all activities permitted to all citizens; and
(*iii*) the possibility of obtaining information about the purposes for which his or her work is being done.

The committee on Science and its Social Relations instituted by the International Council of Scientific Unions has also raised the question of giving attention to *man* himself as the fundamental unit of society and therefore has asked everybody to consider three principal aspects of social relations of science, viz. :—

(*i*) the scientist before society;
(*ii*) changes introduced in human societies through the technological development of science;
(*iii*) the antagonism between biological order and social order.

In the world generally the fall of the Fascist States has left a kind of vacuum in beliefs, which must be filled; and if the democratic state has not the dynamic energy to draw to itself the affirmative allegiance of the younger generation in India then the democratic state will not have a healthy growth. The case is not simple 'patriotism'. The task of education is, along with other institutions of the state, to furnish this dynamic. But it must be an intelligent dynamic. Hence it must deal with the individuals as units of the society. Dr. Rajendra Prasad, while he was the President of the Indian Constituent Assembly, stated at Wardha that "we must concentrate on the individual, on whom depends the solution of many problems confronting the work; the individuals jointly constitute a nation. We have to reform the individual, make him really an instrument of peace so that he may influence other individuals around him. He may influence his Government. Mahatma Gandhi tried to mould the individual throughout his activities in Africa and in India; it was individuals whom he moulded and he hoped that in that way he would be able to create a society of men in the light of his teachings. We have to take decisions which will help individuals, and which will help us all individually to create that kind of society which will banish war".

Professor Bernal just before the World War II emphasized the same aspect from the stand point of a scientist. He stated—"we have in the practice of science the prototype for all human common action. The task which the scientists have undertaken—the understanding and control of nature and of *man himself*—is merely the conscious expression of the task of human society. The methods by which this task is attempted, however imperfectly they are realized, are the methods by which humanity is most likely to secure its own future. In science men have learned consciously to subordinate themselves to a common purpose without losing the individuality of their achievements. Each one knows that his work depends on that of his predecessors and colleagues, and that it can only reach its fruition through the work of his successors. In science men collaborate not because they are forced to by superior authority or because they blindly follow some chosen leader, but because they realize that only in this willing collaboration can each man find his goal. Not orders, but advice, determines action. Each man knows that only by advice, honestly and disinterestedly given, can his work succeed, because such advice expresses as near as may be the inexorable logic of the material world, viz. stubborn facts. Facts cannot be forced to our desires, and freedom comes by admitting this necessity and not by pretending to ignore it. These are things that have been learned painfully and incompletely in the pursuit of science. Only in the wider tasks of humanity will their full use be found."

The Prime Minister of India is most anxious that the students in the Universities and technological colleges in India should know how through the instrumentality of science the political and social conditions of India are rapidly changing. The application of natural sciences for social welfare, the utilization of natural resources for social welfare, the application of biological sciences for social welfare, the engineering developments for social welfare, the social problems of an industrial civilization, are merely some of the vast number of topics which require careful attention of the faculties of science, technology, commerce and education of the universities in India.

Professor J. D. Bernal in his well known book "The Social Function of Science" has made a critical examination of the function of science in society. He narrates what science does and mentions what science should do. In the preface to his book, he says :—"It used to be believed that the results of scientific investigation would lead to continue progressive improvements in conditions of life; but the war and then economic crises have shown that science can be used as easily for destructive and wasteful purposes, and voices have been raised demanding the cessation of scientific research as the only means of preserving a tolerable civilization. Scientists themselves, faced with these criticisms, have been forced to consider effectively for the first time how the work they are doing is connected with the social and economic development which are occurring around them. . . . . To begin with, it is necessary to consider the social function of science not absolutely, but as something which has grown up imperceptibly with the growth of science. Science has ceased to be the occupation of curious gentlemen or of ingenious minds supported by wealthy patrons, and has become an industry supported by large industrial monopolies and by the State. Imperceptibly this has altered the character of science from an individual to a collective basis, and has enhanced the importance of apparatus and administration. But as these developments have proceeded in an uncordinated and haphazard manner, the result at the present day is a structure of appalling inefficiency both as to its internal organisation and as to the means of application on problems of production or of welfare. . . . . The application of science furnishes other problems. Here the tendency in the past has been almost exclusively that of directing science towards improvements in material production primarily through lowering the cost and towards the development of the instruments of war. This has lead to an almost complete neglect of those applications which would be of more immediate value to human welfare, in particular to health and domestic life. The result has been an extraordinary disproportion in the development of different sciences, the biological and still more the sociological sciences having been starved at the expense of the more immediately profitable physical and chemical sciences. . . . Any discussion of the application of science necessarily involved questions of economics, and we are driven to enquire how far the various economic systems now existing or proposed can give the opportunity for the maximum application of science for human welfare. Further economics cannot be separated from politics. . . . . The universal preparations for a more general and terrible war have affected scientists not only as citizens, but also through their work. Science itself seems in danger. The scientist has begun to realize his social responsibility but if science is to fulfil the function which its tradition demands, and to avoid the dangers which threaten it, we require an increased appreciation, both on the part of scientists and of the general public, of the intricate relations between science and contemporary life."

The part played by various mineral substances in national economy, the geographical distribution of mineral occurrences and its bearing on the question of possible mineral sanctions have brought the science of geology (including physical geography) to the forefront of national progress. The discovery and exploitation of metallic ores and oil have been greatly assisted in recent years by improvements in geophysical prospecting. The foundation of geography is obviously a complete and precise knowledge of the physical features of the Earth's surface—mountains, deserts, rivers, lakes and islands. Our present knowledge is the cumulative result of a vast number of journeys by explorers and travellers of many nationalities. To them we owe much of our knowledge of the conditions in which a great proportion of the peoples of the world are living. The advance in the subject in various directions is bringing environmental sciences like climatology, anthropology, etc., into greater prominence. The application of aerial photography is being continually developed and maps are being revised and governments of big countries are preparing or revising their national atlases. The Mount Everest Expedition and other expeditions have added to our knowledge of Himalayan topography, biological adaptation to high altitudes and meteorological conditions. The study of nuclear constitution carried on with wild plants as well gave valuable information concerning the relationship and the geographical distribution of plants. In Ecology, Zoology links up with Botany. A principle of great interest from the zoological point of view has recently been propounded that undercrowding may be as lacking in stimulation to reproduction as overcrowding, and that there is a physiological optimum density of population. Further the phenomenon of variation and fluctuation in numbers in population has developed the science of statistics in the field of biology and other related subjects.

The processes of learning, retention and forgetting continue to engage the attention of psychologists. Particular interest is being devoted to the subject of the variation of ability and learning powers at adult ages. This is and will have a great social bearing on the education of the illiterate adults numbering many millions in India. As regards mental testing in general there has been an increasing tendency to carry out large surveys in different geographical areas. Industrial psychologists are rendering considerable service to the people in general by their researches in guidance in specific avocations of life.

The natural resources of a country provide its wealth. The scientist and the engineer create it, economist attempts to control its distribution. The standard of living in the present day world is directly dependent upon the intelligent and continued use and development of these resources. Science and engineering have a deeper meaning than the mere utilisation of resources or development. It is an instrument of social progress. History has shown that the great advances in literature, art and philosophy have been made by comparatively few people who were provided, through the economic and social systems in which they lived, with the opportunity of devoting their time and energies to such advancements. In the early days this meant that many slaves were required for every scholar or member of the intelligensia who was not devoting his time to the process of earning his own living. Today scientific and engineering achievements are providing an equivalent of a large number of slaves for every man, woman and child, and in so doing it gives to all people the opportunities for an intellectual development that heretofore was restricted to very few. Engineering is not only necessary but it is also the key to technical, social and economic progress. This progress cannot be attributed entirely to the presence of natural resources. Such resources have been present for years. It has taken millions of years to bring them to human usefulness. The science and technology, through the scientists and engineers, have largely contributed to the world problems, social and economic, and to reach the mass of the country. India faces today problems of vast magnitude in her development of her social and economic conditions in which science and engineering are of paramount importance.

We speak of over-production when we never had a decent general standard of living in this country; we speak of technological unemployment when it is on technology alone that we find our solutions for higher standard of the future; we speak of our investments when an adequate provision of goods and services to the mass of our fellow citizens require large and more efficient production facilities than we ever dreamed of. In India, to-day, the conditions are changing rapidly. Policies for national welfare are in need of guiding principles. Knowledge of probable scientific and technological trends is a good help; the material factors that shall determine the economic well-being of India are the development of her scientific and technological progress and economic organisation. In a country which is trying to achieve a rapid growth and which has hitherto remained under-developed, scientifically and technologically, the first requisite is its scientific and technological achievements and their social effects later. The significance of technology for social and economic life may be given by considering certain developments of the twentieth century. Only half the century out of the twentieth century has elapsed during which the world has experienced a phase of unparalleled development. A scanning of these technological developments would reveal the present material prosperity of the western countries.

What is India's main requirement today? Food. Until 1952, every year hundreds of crores of rupees were being melted away in buying this most essential commodity in the areas of hard currencies. India is an agricultural country and should be able to more than support herself. The other problems that are facing us are a good deal of unemployment and increasing our productivity of consumer goods. These require overall measures of increasing volume of goods and services produced in the country, and the volume of labour employed in the creation of national products.

Agriculture in India today is not an industry. Because of the large variety of technologies which bear on agriculture, specialists in these fields have to contribute greatly to technological change in agriculture. The present day productivity of the average worker in agriculture is meagre. The methods of agriculture have to be studied. Mechanisation of agriculture have to be adopted to suit Indian conditions and will have to be arranged so as to depend for its general utilisation upon the economic and physical feasibility of the country and the people. Various problems here are involved where a scientist and an engineer has to give all his best in helping the expansion of farming into new lands suited to large scale methods of production, in increasing the farm labour efficiency, in giving them electricity, in providing refrigeration for farm and dairy produce, in the reclamation of arid lands, in providing better farm buildings, in irrigation, and in pumping, in plant breeding and improvement. It does not end here. The domestic farm animals represent millions of highly adaptable factors for food, fibre or power. Health and security are major objectives of the human race. Domestic animals and their products with the benefit or means of research and technology seem to offer increasing aid towards those objectives. The technology also bears a relation in regard to the farming in the study of its soil, its use and conservation, in chemical fertilisers.

Engineering in its social relation and uplift of the country, has also the task in front of it—to supply the mineral technology, to explore, investigate the supply of fuels and raw materials on which modern life has come to depend on the resources of the under-earth. The minerals have become the greatest of the raw materials of industry, the chief basis of chemical manufacture, the chief materials of construction. The scientist and the technologist have to give it the technique of exploration and technology in mining. Apart from the economic development depending on this, the technologist has also to consider this in the defence of the country and bring his technology to bear towards some strategic minerals.

Kipling's assertion is that transportation is civilisation. In India's planned development transportation is one of the most important factors for its economic and social life. There are questions of railway transportation, highway transportation, water-borne transportation, and air transportation. The commercial air transportation is ideally suited to Indian condition, in consideration of time and space and being primarily adopted to much longer distances than the average passenger journeys. The social effects of a great and highly efficient transportation system today, in India, cannot be denied.

If not the most important, probably one of the most important reasons, for the progressing and widening of the individual human being's perception of the world around him has been the tremendous growth of communications. Radio, telegraph, telephony, special communication channels are all a prelude to India's development in its relation to the social uplift. An engineer has to consider the tremendous implications which underline the balance between engineering developments and the social and economic trends in communication.

It has been said that electricity in modern life is second in importance only to food and shelter. In India, the present power development as compared to the other civilised countries is very small. India's great potentialities must be developed soon. Civilised people of today are dependent upon power—power driven machinery for industries, power driven machinery for the furniture and furnishing of the homes, for clothes, for the materials which enter into building people's shelters, for systems of transportation, for modes of communication, in fact for all the material content of the present civilisation. The very food, drawn from farm, forest and stream, depends on systems depending upon power. Manufacturing, mining, communication, transportation and other fields of production activities have been advanced by power, shortening the time necessary to achieve the results.

The influence of science of chemistry and chemical engineering on all world trends becomes far greater when considered in its relation to social welfare. The products of the chemical industry are rarely recognised by the ultimate consumer as such because they do not reach him as individual products.

In all these technological developments there is the back-bone which is research and has to be recognised.

It is not only the above developments in which is bound up India's social and economic progress but other related parts where science and engineering has to perform its part—development of public health engineering, sanitation, water supplies, etc.

The future role of science and engineering and the scientists and engineers in the social and economic building can no longer be ignored. The Indian developmust has to be carried out on the basis that would take advantage of the peculiarities of the people and of the country. The extent to which India's scientific and technological personnel can bear to bring their interest in encouraging and developing these means will largely determine in the next decade her development as a country of sound social and economic conditions.

In this connection it is worthwhile making a study of the increae in world population. The two tables given below will show the distribution of population in different parts of the world.

World Population in Millions (by Continents).

Continents :	1650	1750	1800	1850	1900	1933	1940	1947	1950
Europe	100	140	187	266	401	519	575	579	589
North America ...	1	1·3	5·7	26	81	137	143	157	165
C. & S. America ...	12	11·1	18·9	33	63	125	132	153	163
Oceania	2	2	2	2	6	10	11	12	13
Africa	100	95	90	95	120	145	158	191	198
Asia	330	479	602	749	937	1121	1155	1238	1272
Total ...	545	728	906	1171	1608	2057	2174	2330	2400

Percentage Distribution.

Europe	18·3	19·2	20·7	22·7	24·4	25·2	26·4	24·8	24·5
North America ...	0·2	0·1	0·7	2·3	5·1	6·7	6·6	6·7	6·9
C. & S. America ...	2·2	1·5	2·1	2·8	3·9	6·1	6·1	6·6	6·8
Oceania	0·4	0·3	0·2	0·2	0·4	0·5	0·5	0·5	0·5
Africa	18·3	13·1	9·9	8·1	7·4	7·0	7·3	8·2	8·3
Asia	60 6	65·8	66·4	63·9	58·3	54·5	53·1	53·2	53·0
Total ...	100	100	100	100	100	100	100	100	100

The chief cause of food shortage is the steady increase in world population. In 1900 the world population was 16 hundred million human beings and in 1950 it was 2,400 millions, i.e., an increase of 50 per cent in 50 years. But the food production has not increased over 30 per cent in these 50 years and, hence, the food situation is gradually deteriorating, specially in India, which has been declared to be the hungriest country of the world in 1953 by the Statistical Department of the United Nations in New York.

The rate of growth of population in many Eastern countries is much larger than in the north west of Europe. For example, India and Pakistan had 385 millions of human beings in 1941 whilst in 1951 it was 431 millions showing an increase of 1·19 per cent per year.

The present rate of increase in the population of the world is about 1% (one per cent) every year. This means that the population of the world will double itself in less than seventy years. As a matter of fact if the average longevity be increased to a figure higher than what it is at present possibly the total population will be doubled by 2000 A.D., i.e. by the end of the twentieth century. This will create a food shortage problem of gigantic magnitude.

In India the rate of increase in population is much higher than one per cent per year. In India the death rate has shown a steady decline from the 'rather high level' of 31 per 1000, during 1931-40 to a 'moderately high level' of about 25 per thousand in 1952. The increase in population has been 14·1 per 1000 in 1941-50, as compared with 10·6 per 1000 in 1921-30. Hence the problem of production of food by means of agriculture, river conservation and control requires immediate attention of agricultural scientists, economists, and irrigation engineers. Primary source of water being rainfall it is a renewable natural resource; but owing to its limited supply and faulty distribution, conservation and control of water are inherent in the problem of its utilisation.

Nature has her own methods for the conservation and control of rainfall as compensation against its erratic distribution by having the precipitation partly in the form of snow if there is any catchment area at sufficiently high altitude, and what is more important, by absorbing and storing underground a substantial portion of rainfall, thereby reducing the run-off and the intensity of floods and at the same time providing a vast subsoil reservoir which, by percolation through the soil, throughout the year, maintains the river flow when there is no rain and no surface flow to maintain it otherwise. The utility of a river to serve our various needs mainly depends on this compensating action provided by nature which again depends on the condition of the catchment, *i.e.* whether it has sufficient area under vegetation, particularly deep forest, which retards run-off thereby reducing the intensity of floods and their silt-content and increases the portion of the rainfall which is absorbed and stored underground to maintain the river flow by subsoil percolation during the dry weather. It is interference with this natural economy by destruction of forests and by other harmful acts in the catchment areas and in the river channel that is responsible for most of our river problems, particularly the flood problem. To meet our growing needs, we want regular supply of water. Hence very many river valley projects have been undertaken by the Government of India. The Damodar Valley Project, the Bakra Langal Project and the Koshi River Project are all examples of schemes for generating power and for production of food and other things (industries) required for the social uplift and well-being of the people of India.

Apparently, there is some conflict between the needs of the river and those of man, as with the growth of population certain amount of interference with nature's economy is unavoidable, as room has to be found for the growing population and their needs from the land including the forests, now rapidly increasing with the progress of civilisation, have to be met. This cannot be stopped but the process should be rationalised. What is required is that with the aid of our advanced scientific knowledge, by intensive study and research, attempt should be made to effect a reconciliation between the above conflicting interests. Mere negative approach may not be sufficient having regard to our growing needs of water. Positive aid to nature's economy is also necessary by rational land management, contour trenching, bunding and terraced cultivation along the hill slopes, together with efficient preservation of existing forests and afforestation where possible etc., all with the object of reducing the rate of run-off and preventing soil erosion. Though necessary in the interest of the various forms of water uses, they are of particular importance as preventive measures against floods. They do not involve much of capital outlay but mainly require organizational effort including research and legislation. They also permit land building activities in deltaic areas which is essential in nature's economy and help in maintaining the dranage system. It should however be emphasized that isolated action in a section of the river is not sufficient but comprehensive planning for the river as a whole is necessary irrespective of political boundary.

Of the remedial measures against floods, the most common is the construction of marginal flood embankment. At best, it is only a temporary expedient as the silt factor complicates the problem. In the economy of nature the silt is intended to be carried with the flood spill so that it could raise and fertilise the land and reduce silt content in the river channel to what its velocity could transport. Embankment interferes with this economy, deteriorates the channel and raises the flood level. It causes progressive deterioration in the drainage system, in public health and productivity of the soil by cutting off beneficial flood spill. Nor can the flood embankments offer permanent solution to the flood-problem as breaches are unavoidable which cause even greater damage due to concentrated discharge than by gradual inundation.

The problem of longevity is closely connected with the protection of human beings freeing themselves from invading bacterias of various types. Hence the researches in preparation of antibiotics have given a welcome relief from anxieties of early death due to infections of various kinds. Scientific and medical journals during the last ten years have been full of reports which testify to the astonishing efficacy of penicillin, streptomycin, auriomycin and othe disease curing medicines. Can man live for ever is now a question that is being asked by many people who have seen what Hormones can do. Profound changes in the organisation of the body of an adult can be brought about by small quantities of known chemical substances, but the nature of the influences which produce normal growth and cause death in the higher types of animals is still unknown. That the over productivity of one of the ductless glands can lead to the production of giants is an indication, but no more. Yet biochemistry is re-exploring the ground first covered by physiology and strengthening the control over bodily processes with which that study had provided medicine. Although most scientists would treat the matter with utmost reserve, we cannot altogether rule out the possibility that some day in the future Ponce-de Leon's Fountain of Youth may become known.

There could be no higher end in the universe than to make a perfect world, and no more perfect moral law than that which at the same moment eliminates the unfit and establishes the fit. Too frequently the moralist's attention is diverted to the negative side, to what seems the quite immoral spectacle of the massacre of the innocent, the route and murder of the unfit. But in earlier Nature there is no such word as innocent; and no ethical meaning at that stage can attach itself to the term 'unfit'. Fitness in the stormy days of the world's animal youth was necessarily fighting fitness; no higher end was present anywhere than simply to gain for life a footing in the world and perfect it up to the highest physical form. The creature which did that fulfilled its destiny, and no higher destiny was possible or conceivable. The Survival of the Fittest, of course, does not mean the Survival of the Strongest. It means the Survival of the Adapted—the survival of the most fitted to the circumstances which surround it. A fish survives in water when a leaking iron-clad goes to the bottom, not because it is stronger but because it is better adapted to the element in which it lives. A bull is stronger than a mosquito, but in an autumn drought in a partially barren country the bull dies, the mosquito lives. Fitness to survive is simply fittedness, and has nothing to do with strength or courage, or intelligence or cunning as such, but only with adjustments as fit or unfit to the world around. A prize-fighter is stronger than a cripple; but in the environment of modern life the cripple is cared for by the people, is judged fit to live by a moral world, while the jugilist or any other able-bodied person, handicapped by his very health, has to conduct his own struggle for existence. Physical fitness here is actually a disqualification, what was once unfitness is now fitness to survive. As we rise in the scale, the physical fitness of the early world changes to a fitness of different quality, this law becomes the guardian of a moral order. In one era the race is to the swift, in another the meek is to inherit the earth. In a material world social survival depends on wealth, health and power; in a moral world the fittest are the weak, the pitiable, the poor. Thus there comes a time when this very law in securing survival for those who would otherwise sink and fall, is the minister of moral ends. Application of science for improving the conditions of life must therefore keep both aspects in view.

APPENDIX

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